SCIENTIFIC AMERICAN SUPPLEMENT

VOLUME LXXXVII
NUMBER 2252

★ NEW YORK, MARCH 1, 1919 ★

Published weekly. Entered as second class matter, December 15, 1887, at the Post Office at New York, N. Y., under Act of March 3, 1879

10 CENTS A COPY
$5.00 A YEAR

A scene in one of our great cattle markets

AMERICA'S FOOD RESOURCES [See page 136]

Manufactured Ships*

New Methods to Meet Unusual Conditions

By J. D. MacBride, Superintendent in Hull Construction, Hog Island, Pa.

THE term "fabricated ships" has been applied recently to ships which have been constructed in accordance with the methods adopted by shipyards established to construct merchant vessels for the United States Government. Many have formed a wrong idea of the term "fabricated." Anything which is fabricated is formed by assembling a number of separate parts; therefore, the prevailing method of construction produced a "fabricated" ship. The correct term should be "manufactured ships."

Prior to the World War, if a company should decide on the addition of another ship to its fleet, it would arrange to finance its construction. Proposals which outlined the type of ship desired would be issued to a number of shipbuilders. The contract would be placed with the company which submitted the lowest bid or submitted the design which best suited the requirements.

The shipbuilding company would develop new designs for the ship to meet the special requirements of the owners, and relatively few standard designs were used. Considerable expense was involved in the development of these designs, new patterns and new templates. After the ship was constructed, the designs would be filed away in a vault, to be consulted at some later date if the shipbuilders should receive orders to construct a similar ship. The wood patterns and templates would often be destroyed for lack of storage room.

Any manufacturer accustomed to manufacturing standard articles would consider that such a method represented a great waste in time and money; but our shipbuilders have not been manufacturers. They were required to meet conditions as they found them, and often the determining factors of the design were out of their power to control, and therefore the development of the design for ships had no general application until recently.

About eighteen years ago a shipyard was laid out in accordance with the most modern ideas with a view to rapid and systematic work. The president of the company announced that his plant was equipped to construct one ship per month. The yard started with a few orders, and although it has always had enough work on hand to keep in operation, it has not been able to secure orders for even a fraction of that number of merchant vessels.

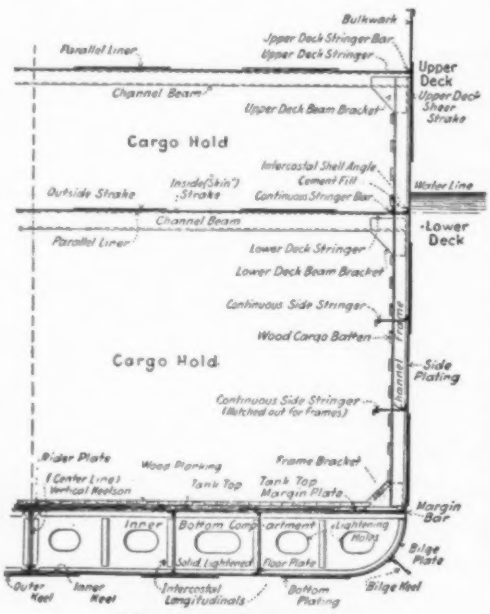
About 1904 one of our leading marine magazines published the important announcement that "on the following page is a full and complete description of all the ships now being built in the United States for overseas trade." The following page was untouched by printer's ink. Under these conditions there was no chance to develop "quantity production." The shipbuilders in the past have been builders rather than manufacturers because of the small volume of orders received.

The advent of the war brought its many new problems and conditions surrounding the employer and employee. The older systems for handling men and material it was therefore necessary to change. The tremendous amount of ocean-going tonnage required by our Allies and ourselves raised the question as to how we could build a sufficient number of ships in the quickest possible time. When our shipyards were started in the race against the German submarines—to build ships faster than submarines could destroy them—the Government was anxious and willing to start new shipyards and to award contracts to these yards for as many ships as it was considered they could possibly build. The well-established yards with their well-trained staffs were in a position to proceed at once with new construction work, and turn it out quickly and cheaply; but in the meantim a large building program for naval vessels of all types was started. The building of a merchant cargo carrying ship is quite different from building a superdreadnaught or battle cruiser, and even the destroyers of the present types present more complex construction problems than the torpedo boats and torpedo-boat destroyers of a few years ago. The established shipyards were assigned naval construction work, and for this reason they were unable to engage in the construction of merchant marine vessels in large quantities.

THE STANDARD MERCHANT SHIP.

The construction of our new merchant marine started with a mushroom-like growth, but fostered by the Emergency Fleet Corporation, it has been possible to accomplish many things that without its aid could never have been done. Many of the new yards were constructed at the same time, and it was possible to plan them with an accurate knowledge of just what the requirements would be. As the development of the shipyards proceeded, so did the scheme for constructing the ships, and for the first time in the shipbuilding history of the United States, or, in fact, any other nation, it was found practicable to build ships of the same design in large quantities. Orders were placed in multiples of twenty or twenty-five which gave the new shipyard managers an opportunity to undertake the task in an entirely different manner from previous practice.

The basis for estimating on bids and all other costs is a "cost per ton." The cost per ton is based on a great number of small items, each of which must be carefully considered, analyzed and the cost of production reduced to a minimum. During construction, if the same shaped plate can be duplicated twenty-five times or more without changing the pattern or requiring the men to become accustomed to getting out a new shape, this will certainly tend to produce fast and accurate work, much more so than if it is necessary to be constantly laying out new shaped plates. The idea of quantity production involved changes in the established details of design in order to secure fast and easy construction. In order to receive the material on the shipways as rapidly as it could be erected, it was found necessary to have it prepared outside of the shipyard, and delivered in condition for immediate



CROSS SECTION OF CARGO STEAMER

erection. This introduced a new feature in shipbuilding, that of using many shops, often widely separated in the country, to construct material which, when received, could be assembled without delay on arrival at the shipway.

DESIGN OF HULL.

Much of the material classed as "ship steel" with its special properties regarding tensile strength, etc., was being used by the older yards in the construction of naval vessels. In order to obtain the necessary material for the construction of merchant ships it was necessary to obtain special permission to use "structural steel," which could be obtained in the required quantities. The shops which were capable of preparing the different parts of the ship were those which had been doing bridge, tank and boiler-work. In order to simplify the construction of the hull, the naval architects of the shipbuilding companies developed designs which simplified the shapes of the boats but with forms which could be easily propelled through the water. To their credit is due the proportions of the new boats which have the characteristics of regular ship-shape forms but are much easier to assemble. The under-water portion of the vessel compared to a rectangular solid of the same length, width and depth has a coefficient of about 0.76. This is practically the same as the usual type of design, although some ships have been built with a much fuller under-body, the coefficient going as high as 0.78 and above. The coefficient of 0.76 is obtained by carefully designing the "moulded" part of the ship. The midship or "dead flat" portion of the vessel is carried as far forward and aft as possible. This will often extend from forty to forty-four per cent. of the total length of the hull, and it is in this portion that the duplication of frames and parts of the hull structure is made. Forward and aft of this portion of the hull the frames of the boat change shape so that it is necessary to mould each frame separately. In order to maintain an even depth of floor and longitudinal in the inner bottom, the outside bottom plating of the hull was made level instead of having a "dead rise" of about nine to twelve inches, which is the usual practice. The sides of the ships have usually been formed on a curve which swung in toward the center line of the ship a little as the side extended up from the bottom plating. This is called "tumble home." The new design made the sides vertical from the round at the bottom called the "bilge." The usual design makes the bilge of the ship an "easy" curve to the lines of the side and bottom. The new design made this curve an arc of a circle so that the plate could be rolled and punched with much greater accuracy than was possible with any other form. When the amidship portion of the vessel has a flat bottom, flat sides, and a radius at the junction of the two, it is much simpler to get out material in the shops than for the usual ship-shape form. The radius at the turn of the bilge is about three and one-half feet, and the flat sides and bottom plating make easy surfaces for the template men.

When developing the design of a hull, the draughting room lays out the "lines" which are curves of intersection formed by passing horizontal, vertical and transverse planes through the hull. The curves formed by the intersection of the horizontal planes with the hull are called "water lines." The transverse planes form the "frames." The designer obtains from these curves the necessary data for determining the displacement, center of buoyancy, etc. After the lines have been approved, a table of "offsets," *i. e.*, the heights and half-breadths of the curves forming the frames and sheer lines, is prepared and sent to the Mould Loft. The Mould Loft has a very large, smooth floor where the curves of the frames are laid down full size on what is termed the "scrieve board." Templates of either wood or heavy paper, as the case may be, are then made of the curves on the scrieve board, and the spacing for rivet holes and other information is placed on these templates. It was necessary at the "fabricated" yards where templates were sent a long distance to plate mills, to develop an elaborate system for checking the work and making the necessary allowances for discrepancies. The procedure is described by Mr. Henry R. Stuphen, in a paper he presented at the last annual meeting of the Society of Naval Architects and Marine Engineers.

CONSTRUCTION OF HULLS.

"In the moulded portion[1] of the ship, however, the problem became more complicated to the bridge engineer, as this section of the shell could not be mathematically developed. Such plates and shapes were developed full size on the mould-loft floor, reproduced on template paper, having all rivet holes punched in them on proper gauge lines and for a matter of record carefully measured up and detailed to dimension or individual drawings. Even with complete drawings it was difficult for the fabricating shops to reproduce the plates on account of the edges and gauge lines being curved. These lines could only be located by dimensioning a series of points on the curves.

"As we could not count upon two men springing a batten and getting the same shape between points, we overcame this phase of the problem by sending templates of the shell plates in the moulded sections to the fabricating companies. These templates, made on template paper approximately 1/32-inch thick, were direct copies of the original template developed on the mould-loft floor. A difficulty was experienced in the shrinkage and expansion of these templates and, to insure the change of shape of the templates causing no misfits, each template was marked before being sent out with certain dimensions. To begin with, the paper used is

[1]The moulded portion of the hull is that portion which extends from the "dead flat" or "parallel body" to bow and stern. The frames are identical throughout the dead flat portion.

*Journal of the Engineers' Club of Philadelphia.

fairly heavy fabroid material, which has a rather low coefficient of expansion. It was then marked and cut in accordance with the development on the scrieve board, and rivet holes, etc., were laid out upon the paper, spaced and dimensioned with great accuracy.

"The correct dimension for the length of the template, also the correct dimension for width at each end, was painted on with arrows indicating exactly where these dimensions were taken. In addition to this, a straight line was scratched the full length of the template approximately at the center line. The shop receiving this template was requested, in all cases before using it, to measure it and make certain that the template, as they used it, was correct to check the dimensions given. They were also requested to test the straight line scratched on the template with a straight edge. When, as was very frequently the case, they found that the dimensions did not check or that the line was not straight, they were required to bring it to shape either by dampening it or drying it, as the case might be. There still remained, of course, the possibility that when a template had been expanded by dampening and stretching, the expansion might have taken place all at one section of the plate rather than throughout its length. As it was possible for this to happen, neither checking the dimensions on the template nor checking the straight line would detect the error. To overcome this we insisted that the fabricator check their templates against the detailed drawings which were furnished them. Inasmuch as the local steel tapes determined the measure of this variation, it was of prime importance that every tape at each and all of the outside works should be uniform.

"A single tape was selected for the Newark Bay shipyard, where original templates and drawings were laid down on the mould-loft floor, and with this master tape every other tape to be used was compared and carefully calibrated, and a coefficient, plus or minus, prescribed in each case. In this way it has been entirely practicable to insure dimensional agreement not only within the different departments of the Newark Bay shipyard, but similarly within the different departments of every outlying contributive establishment.

"This seemed a large amount of checking, but it must be remembered that in each case this had to be done only once, as the majority of shops, after getting their template exactly as required, used it to lay out one steel plate or section which was used as a template for all duplicate operations. A tolerance of 1/16-inch was allowed on all punching, this being the amount of reaming that is done when the material is being erected."

The shops which are preparing material for the "fabricated" yards are located all the way from Montreal to Virginia and as far west as Kansas. It was necessary to distribute the work over this large territory because so much was attempted at one time. This method has not always saved as much time as it was at first thought it would, due to frieght congestion. Many times the material has been manufactured in Pennsylvania, shipped to some plate shop, where it was prepared according to the template furnished and then shipped back, sometimes past its original starting point, to the shipyards. Much time was lost last winter during the severe weather on account of the trouble experienced by the railroads in keeping their trains moving.

If the ships constructed in accordance with the methods just described prove satisfactory, it is probable that additional plate shops will be built near the rolling mills where the plates are manufactured, which will avoid the extra hauling with its attendant loss in time and extra expense.

It has been customary to design all ships with "sheer." This means that the decks are the highest at the bow, the height is decreased amidships and then rises at the stern to a height somewhat below the bow. This produces a graceful curve which gives the appearance of jauntiness to the outline of the ship. The sheer in yachts is generally for appearance, but it also provides extra buoyancy at the bow, which is very desirable for the vessel in heavy weather, as it provides more "freeboard," or the height of the deck above the surface of the water. In merchant ships, where the appearance is not so important, the extra height at the bow is required by the marine underwriters in order to provide additional safety for the vessel. If, for any reason, the sheer is less than the usual custom, the underwriters require that the ship shall have extra strength to resist heavy weather conditions, such as when the bow is buried under tons of solid water.

The deck beams, in accordance with the time-honored custom, have been designed with "camber" or "crown," which consists in bending the deck beams to a curve which has about one-quarter inch drop per foot. Keeping in mind these two points of "sheer" and "camber," a brief description of the types of ships now being built under what is called "fabricated," but which is really the "manufactured" system, may be of interest. There are three ship-yards at present which may be termed "fabricated yards," and they are receiving practically all their material for their ships from outside sources. These yards are operated by private interests but receive from the Government financial assistance in obtaining material. Each yard has selected a different design, but the general outlines of the ships are similar.

TYPES OF HULLS.

One of the yards is building vessels of about five thousand tons. There is no dead rise to the bottom, the sides are straight and vertical, and the decks have no camber. The sheer is obtained by carrying the height of the decks in a straight line to the bow. The height at the bow is about five feet above the height amidships. This straight-line effect is not so noticeable in comparison to an easy curve, because the profile of the ship is broken by the added height of the hull forward to meet the forecastle deck, and the height amidships to meet the bridge deck. The firm was not required to add extra strength in the form of additional reinforcing material.

A second yard is building vessels with no sheer or camber on the deck beams, but extra strength has been added to compensate for this departure from the customary practice. The vessels are about 7,500 tons, and are a little longer and broader than the vessels mentioned in the previous paragraph.

The third yard is building ships of about 9,000 tons. These ships have considerable sheer and a straight camber of the weather decks. The camber is made by carrying the deck plating flat on an inclination rising to the center line of the ship which forms a ridge fore and aft.

About ninety to ninety-six per cent. of the entire structure of the ships is sent from various shops to the shipyard, all of it ready for erecting in place. The parts which are not fabricated outside are portions of the shell plating which are very difficult to develop on the mould-loft floor, and which require little time, comparatively speaking, to lay out and adjust on the ship. These plates are usually called "furnaced" plates, because it is necessary to heat the plates in a furnace, to bend and hammer them into shape to suit the templates. It is very difficult to make these plates fit exactly to the plates in their immediate vicinity in the hull, and it is not advisable to have them punched for riveting until they have been properly fitted.

FABRICATED MATERIAL.

Fabricated material, so called, is that which has been sheered, planed and punched in the plate shops from templates which have been furnished. It might interest those who are not acquainted with shipyard practice to learn that templates have been used for the construction of ships for many years, but their application has not been so extensive as in the case of "manufactured ships." Usually the framework of a ship is erected with the rivet holes punched, the plating, such as the hull, deck and bulkheads, has been partially laid, and templates are then made directly on the ship from the surrounding plates for the plates which are to fit in between them, or, in other words, a row of shell-plates would be laid off and punched to suit templates from the frames after the frames are in place. The inner row or "skin-strake" of plating would be laid parallel to the second row beyond, and so on. When these plates were in place the outside "strakes" would be laid off from templates which were made by placing the template over the place to be covered by the plate and marking the edges and all rivet holes.

The work of making the templates is called "lifting" the shell, deck, or bulkhead plating. From this description it will be evident that formerly the work of building a ship was greatly retarded because a portion of it had to be constructed before the remainder could be laid out and prepared for shearing, planing and punching for rivet holes. If material is so prepared that it can be erected at any time, much of the total time allowed for building the ship ready for launching can be saved.

During the building of the *Quistonck* the writer—who personally laid the keel and had charge of building the ship, which was laid on the first of the ten ways of his division—was obliged many times to lay outside strakes first, and then shove into place the inside strakes, due to the delay in delivery of the material. This illustration is given to show that it is possible to plate any portion of the ship with the material as it arrives, so long as the framing is in place, which would have been impossible with the former method of hull construction, where the work would have been delayed until the inside strakes were in place.

The foregoing description of the modifications which have been adopted in the form of the hull in order to secure as easy work for erection as possible may be supplemented by a brief description of how the individual sections are assembled, although they were fabricated hundreds of miles apart.

DETAILS OF HULL CONSTRUCTION.

The keel of a modern merchant ship is usually a flat plate, although some designers prefer two plates, forming an inner and outer keel. The inner keel is not as wide as the outer, which allows ample width for the edge lap of the first strake, called the "garboard" strake, of the shell-bottom plating. Some of the fabricated ships have one keel plate and others two, there being little difference in the work and the matter is a small item in the general design of the ship. The inner keel plate extends usually only along the amidship portion, where the greatest strain will come when the ship is in a heavy seaway. The plates are delivered all punched for riveting to the floors and garboard strakes. The center vertical keelson is a heavy plate which stands on edge upon the flat keel plates, along the center line of the ship. The keelsons are sent to some of the yards with the rivet holes punched, but in other yards the angles at the top and bottom have been riveted in place with a portion of the angle extending beyond each end sufficiently to "break joints" when the whole have been assembled. Where the keelsons have been delivered with rivet holes punched, the yards have found it necessary to rivet the top and bottom angles before the date set for the laying of the keel, in order to save time. Where the keelsons were delivered with bounding angles riveted on, the shop fabricators have riveted together two of the keelson plates, making a "butt-lap" at the joint of the two ends. This materially reduced the work of the men who were assembling the hulls. When the first shipment of riveted keelsons was inspected at one of the yards, the old-time shipbuilders noted that the riveting was all "snap" heads and points, and there was some doubt as to whether the tests for watertightness could be met. The riveting, however, had been done in a heavy, hydraulic machine and was found to be excellent.

The importance of watertightness can better be understood when it is explained that the "inner bottom" formed by the shell and "tank top" plating is really a large tank divided into a number of compartments, many of them containing oil and others containing fresh water. It is absolutely necessary that these tanks be free from leaks and the inspection is very rigid. These tanks are tested by hydrostatic pressure due to a head of about 36 feet.

The "floors" are vertical girders laid at right angles to the keelson and secured to it by double angle bars. There are in general three types, viz., the "solid," which are lightened by cutting holes; the "watertight," which form one end of a compartment or tank, and the "bracket," which is built of plates at the two ends and heavy angles for framing.

The "floors" were shipped to all the yards, riveted and ready for installation. In one of the yards floors were received, riveted to a small portion of the intercostal longitudinals, which saved time on the shipbuilding part of the program. This method was used for some of the small ships, but would not be applicable for the larger ships.

The longitudinals (side keelsons) were shipped to suit the location, some being for one frame space only, and others for three frame spaces. The framing of the ship was designed to have one solid floor every third frame, with two bracket floors between. Some difficulty was anticipated in fitting the longitudinals but very little was experienced.

In older designs it has been customary to carry the "tank top," which is a deck forming the top of the inner bottom, level to the outboard strake of plating, called the "margin plate," where it was turned down to about right angles with the bilge plating. One yard adopted this design, but the other two carried the tank top out level to the side of the ship, just above the turn of the bilge. By so doing the work of fitting the margin plates was much simplified, as well as the work of erecting frames, because the workman had a good square surface to work on. The beam brackets were riveted to the frames before delivery at the shipyard and punched for rivet holes. The frames are structural steel channels, and amidships are without curvature or bevel. The shell flange of the channel is punched for the shell plating rivet holes before the

(*Concluded on page 139*)

Stocks and Pillories of Old England*

Practical Instruments for Promoting Morality

To be set in the stocks, or the whipping-post or made to stand in the pillory as a scurril rogue, was a favorite punishment in the Merry England of olden time, and many another besides rogues, vagabonds, cheats, and the drunken and dissolute were made to experience those disciplinary methods. For, to be a reformer, a man born to preach his theories before they were quite welcome—as all reformers must needs do—was

Elaborately carved whipping post in the tower of Waltham Abbey Church, Herts.

to be in the eyes of the authorities a "rogue" and scurrilous.

I am led to these remarks by an enquirer who desires to be informed, "Do I know of any stocks and pillories?"

O! my *dear* sir, do I not know of a couple of hundred stocks by the wayside and also of an assortment of pillories! No engines of punishment (I will not declare they were also instruments of justice) are more common than are the decaying old stocks in our villages.

Often you will find them by the churchyard wall, for the clergy were ever keen to punish.

There is, indeed, a lovely whipping-post, together with a fine pillory, preserved within the tower of Waltham Abbey Church. The first, 5 ft. 9 in. in height, is most elaborately carved, and is dated 1598. I do not know that the persons who were secured by the ankles and wrists enjoyed standing imprisoned by it any the more because it is so elaborately carved in the Renaissance manner, but that it is so lovingly decorated does at least show you that the authorities in Waltham cleaved to this discipline and thoroughly loved it.

I show you exactly what it is like in the illustration. Unfortunately I cannot display the pillory that stands beside it because it is too tall, rising to 14 ft. These specimens came from the Market House, which was demolished in 1852.

But the pillory is almost exactly in the likeness of that well-known specimen which stands outside the Market House in the quaint little hilltop townlet of Coleshill, Warwickshire. You will gather from the construction of it that the offender was made to stand on the raised platform, with his head thrust through one of the large holes and his wrists through the smaller ones on either side. Coleshill, as you will see, provided accommodation for two delinquents at one time, and also used the lower part of the machine as a whipping-post.

The punishment of the pillory was, in isolated instances, known in this country as late as 1837, when it was abolished by statute. The pillory was a useful institution, for it was a punishment for misdemeanors against the well-being of the community, such as forgery, trading with false weights and measures, libel, seditious writing, and perjury.

There can hardly ever have been a time when the stocks were unknown. Job is made to speak of being put in the stocks, and we are told that the prophet Jeremiah had the same experience. That is the worst of being a pessimist as well as a prophet. These stocks "were in the high gate of Benjamin, which was by the house of the Lord" (Jer. xx., 2). That is to say, they were by the church, which confirms my earlier remarks.

They were also familiar to the Anglo-Saxons. As for Shakespeare, he frequently mentions them, but, if my memory serves, we do not actually see in his plays anyone in the stocks.

They seem to have been so useful in old England that an Act of Parliament was passed in 1405 providing that a pair should be part of the equipment of every town and village; every place which did not so furnish itself to be regarded henceforward as merely a hamlet.

This horrible threat of degradation recalls "The Mikado," in which the Emperor of Japan, "struck by the fact that no executions have taken place in Titipu for a year, decrees that unless somebody is beheaded within one month the post of Lord High Executioner shall be abolished and the city reduced to the rank of a village."

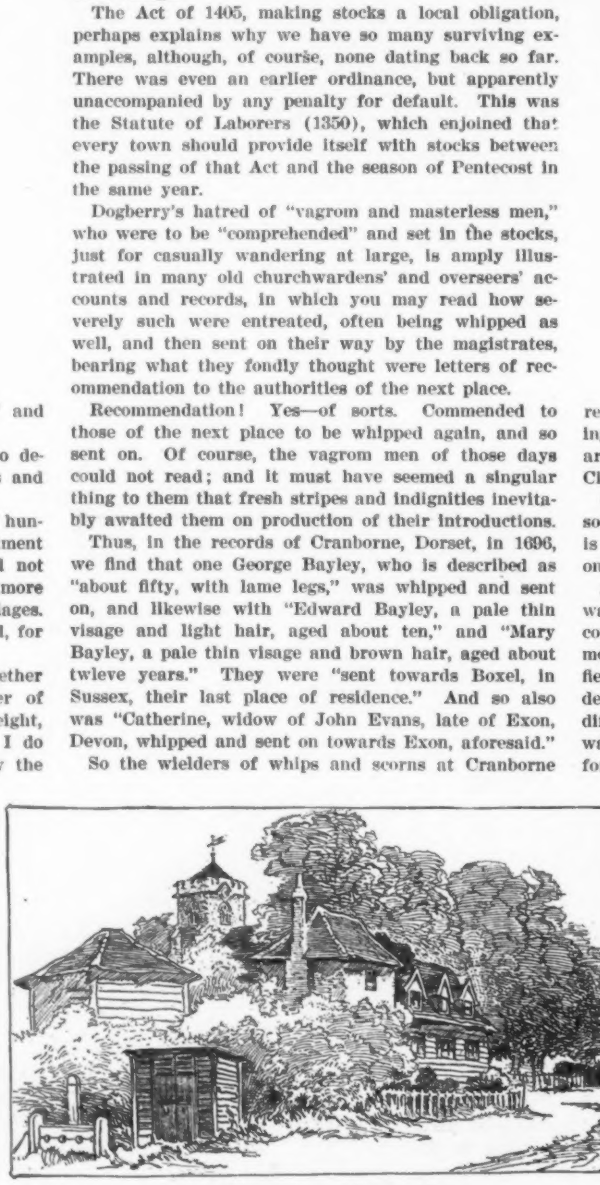
The Act of 1405, making stocks a local obligation, perhaps explains why we have so many surviving examples, although, of course, none dating back so far. There was even an earlier ordinance, but apparently unaccompanied by any penalty for default. This was the Statute of Laborers (1350), which enjoined that every town should provide itself with stocks between the passing of that Act and the season of Pentecost in the same year.

Dogberry's hatred of "vagrom and masterless men," who were to be "comprehended" and set in the stocks, just for casually wandering at large, is amply illustrated in many old churchwardens' and overseers' accounts and records, in which you may read how severely such were entreated, often being whipped as well, and then sent on their way by the magistrates, bearing what they fondly thought were letters of recommendation to the authorities of the next place.

Recommendation! Yes—of sorts. Commended to those of the next place to be whipped again, and so sent on. Of course, the vagrom men of those days could not read; and it must have seemed a singular thing to them that fresh stripes and indignities inevitably awaited them on production of their introductions.

Thus, in the records of Cranborne, Dorset, in 1696, we find that one George Bayley, who is described as "about fifty, with lame legs," was whipped and sent on, and likewise with "Edward Bayley, a pale thin visage and light hair, aged about ten," and "Mary Bayley, a pale thin visage and brown hair, aged about twleve years." They were "sent towards Boxel, in Sussex, their last place of residence." And so also was "Catherine, widow of John Evans, late of Exon, Devon, whipped and sent on towards Exon, aforesaid."

So the wielders of whips and scorns at Cranborne



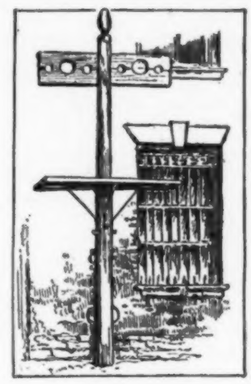
Stocks and old lock-up at Roydon, Essex.

seem to have thoroughly enjoyed themselves on that occasion. We cannot say the same for their visitors, who must have contemplated with foreboding the long ways they had to go to their "last place of residence," their journey rubicated with lashes.

It seems to most people a curious thing that so Puritanical measure as the "Lord's Day Observance Act" of Charles II.'s time should have come into existence at a period so notoriously lax and material. But it is generally forgotten that although the Court was scandalously immoral, and although large sections of the country were wearied of Puritan rule and welcomed the Restoration, yet England in general had a very strong leaven of morality and Sabbatarian feeling. Hence this Act, which forbade Sunday trading, and even awarded money to informers. The Act, by the way, has never been repealed, and convictions under it are occasionally reported. But no longer are offenders set in the stocks.

Some twenty years ago a newsvendor was convicted at York for Sunday trading, and sentenced to this punishment of the stocks in the alternative of paying a fine. Had he not paid, the difficulty would have been to find the stocks in that region.

I find among my notes an even later instance. At Cleethorpes, Lincoln, on August 3rd, 1909, a confectioner, refusing to pay a fine for Sunday trading, was threatened with the levying of a distress, but pointed out (through his solcitor, I suppose) that under the ancient Act the only alternative to a fine was imprisonment in the stocks for two hours, which he was quite



The pillory outside the Market House at Coleshill, Warwickshire.

ready to undergo. He then left the court without paying, the justices remaining in a dilemma because there are not any stocks left of a workable character in Cleethorpes.

Of course, although these surviving instruments are so many, few are in working order. The wood of them is decayed, the padlocks are gone, and the little bench on which the offender sat has but rarely survived.

A curious case brought under the Act just mentioned was that in respect of Bridlington pier, which was completed in 1848. Some two hundreds of the workmen employed on it were summoned before the Driffield magistrates for working on Sundays, and condemned to two hours each in the stocks. The quaint difficulty then arose that 198 men could not be kept waiting while the first two served their time, and so forth.

The Sunday work therefore proceeded, and the law was brought into contempt. Statesmen should never allow that. Absurd laws should be abrogated, if they cannot be enforced (like the Black List, in licensed premises), else the whole judicial system is in danger of being discredited.

The last actual effective sentence to the stocks seems to have been at Newbury, in the Butter and Poultry Market there, on Tuesday afternoon, June 11th, 1872, when a rag-and-bone dealer of, it would seem, widely-known intemperate habits, upon whom imprisonment in Reading Gaol had failed to produce any beneficial effect, was thus dealt with.

The magistrates in this case seem to have been a well-meaning Bench, who were reduced to this course in desperation at not knowing how to reform this bad character. His offence was drunkenness and disorderly behavior at Divine service in the parish church. The justices thought a public degradation might cure him, and so gave him four hourse in the stocks.

The curiosity drew great crowds of derisive persons, and the sinful rag-and-bone man was suitably ragged. Thus the stocks in this case justified their existence.

At Roydon, in Essex, hard by the church, the stocks, with four holes for the accommodation of two persons, remain beside a black-painted shed which looks like a tool-house, but is really the village lock-up. Here, therefore, we perceive the might and majesty of the law fully displayed.

At Colone, that manufacturing town on the tram-infested road between Preston and Bradford, a curiously unusual development of stocks will be found in the churchyard. They are on wheels, and are designed for a full complement of three persons.

Possibly the idea of these locomotory stocks was

*From *The Autocar*.

that they should be drawn about the town, thus giving the evil-doers' shame the greatest possible publicity. Other wheeled stocks are at Much Wenlock, Shropshire. Among its other antiquities, but a thing of yesterday compared with its surroundings, the old stocks at Aldborough, near Boroughbridge, in Yorkshire, stand out prominently because they are on the green, in front of the former Court House.

The entire picture of Aldborough is one of departed greatness. It was in the days of Roman colonial Britain the place called *Isurium*, and was greater even than *Eboracum*, which was the Roman name for York.

Tesselated pavements, fragments of worked stones, and other relics are preserved in a museum established in 1864 in an old cottage with thatched roof, proclaming itself on a signboard: "This is the Ancient Manor House, and in it you will see the Roman Walls. A great curiosity."

I dimly suspect this to be intended for poetry, or at least verse.

The old brick Court House at Aldborough, in front of which stand the stocks, bears a tablet which details its history, and tells us that "the ancient boroughs of Aldborough and Boroughbridge" elected members of Parliament until the first Reform Act of 1832 deprived them of the honor they had enjoyed, together with the bribery and corruption incidental thereto, since the year 1553.

I think there cannot anywhere else be such a curious collection of odds and ends as may be seen in the little Lancashire town of Poulton-le-Fylde. In the foreground may be seen the stocks, then the market-cross, following upon which is an ancient slab for exposure of newly-caught fish, then a whipping-post, and finally a Jubilee lamp standard. It is like a row of exhibits in a museum.

Many are the places of which it is told that a magistrate, or, as some say, a judge, experimenting one day on what it felt like to be in the stocks, got a friend to secure him in a set. The friend, having locked his feet in, left him. At last the judge grew tired and as the friend did not return, he implored the aid of a passer-by.

"No," said the stranger; "no, old fellow. I bet you were not put there for nothing."

Some time afterwards the same judge chanced to hear an action for a false imprisonment in which counsel sought to minimize the pain and disgrace of being in the stocks.

"Have you," asked the judge, "ever been in them?"

"No," rather indignantly replied counsel.

"Then," returned the judge, "I have, and I assure you it is not at all the light matter you seem to think it is."

Stocks, cross, fish-slab, and whipping-post at Poulton-le-Fylde, Lancs.

The Meaning of Life

"But life does not find our complex human forms ready-made and waiting to be animated. It creates every one of them from the very beginning, and by the aid of the microscope we can watch some of the processes by which life gradually builds up the human or any other embryo into the final form which it is destined to assume. This form is, as a rule, the highest and most complex that the race to which the embryo belongs has reached as yet; and in building up the embryo life always works on the same plan from the beginning, so that the development of each individual form in its preliminary stages is practically a repetition of the history of its race up to that stage; but changes which occupied vast periods of time in the first instance are repeated with the rapidity of a familiar performance which practice has made an easy matter of routine. Our scientific apparatus has not yet the power or the delicacy to reveal to us the very earliest beginnings of life's work; but at least it puts before us very clearly that stage of past evolution in which the ancestors of all the higher animals, including man, were only animalcules, each consisting of a single living cell in which life carried on all the vital functions of the period.

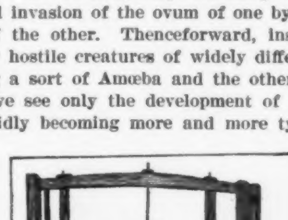
"This cell, which we call an ovum, may be described as being to all intents and purposes a protozoan of the Amœba type—one of the microscopic creatures which exist in abundance today. Their shape is immaterial, and in structure they may be described as little bags of semi-fluid matter in which a small thing, which we call the nucleus, is distinguishable. Their structure is, in fact, very simple; but their life is very simple too. They have practically nothing to do but to draw in their subsistence through the yielding texture of the bag and thus to grow. When they are full grown, life causes the nucleus to split and form a partition across the contents of the little bag, dividing it into two little bags each with a nucleus of its own. And that is how the reproduction of these one-celled creatures usually goes on.

"But the microscope shows us also that when the embryo of any animal which now has two sexes has reached this one-celled stage of life, something very remarkable happens. Another protozoan creature appears upon the scene. It is similar to the ovum in simplicity of structure, but is much smaller and more active. It is like one of the microscopic one-celled creatures that we call flagellate monads—minute things which wander about by means of a whip-lash tail, like tiny tadpoles. This little creature is an invader from outside; and, if we knew nothing more about it and were to judge by appearances, we should certainly conclude that it came upon the scene with a hostile purpose; because it makes its way quickly towards the ovum and actually forces its way into it.

"Now in animal reproduction we call the little invader a spermatozoon; and we have always taken it for

Stocks on the green at Aldborough, near Boroughbridge, Yorkshire.

granted that its purpose is not really hostile, because we know that it represents one-half of the history of the race up to that stage. Since two individuals must come together for the purpose of sexual reproduction it follows that up to that point the history of their ancestors was two-fold, only becoming one after the successful invasion of the ovum of one by the spermatozoon of the other. Thenceforward, instead of two seemingly hostile creatures of widely different kinds—one being a sort of Amœba and the other a flagellate monad—we see only the development of a single embryo, rapidly becoming more and more typical of the



Wheeled stocks at Colne, Lancs.

race to which its parents belong. While they were separate each of the little creatures was animated by the life which had animated its own line of ancestors. When they join, the united life which had animated both lines of ancestors continues to animate the single embryo, insomuch that in future years when it is a separate individual living on its own, it will often surprise us by suddenly exhibiting little peculiarites or tricks of conduct which recall some individual ancestor on either side. Because we are familiar with this blending of life as the consummation of human love, the right explanation of this extraordinary episode of the ovum and spermatozoon has not represented itself to us. We have failed to realize that these two one-celled creatures do not come upon the stage of our past history and behave as if they were enemies without some reason; and perhaps some of you will be as surprised as I was when I discovered the truth, if you will compare the illustrations of spermatozoon and ovum in any modern treatise of embryology with those of protozoan parasites and the living cells which they attack in any book on zoology. Thus the illustration on page 211 of Volume I. of "A Treatise on Zoology," edited by Sir Ray Lankester and written by Professor Minchin, represents the protozoan parasite called Coccidium schubergi attacking a single cell of the lining of the stomach of the common centipede known as Lithobius forficatus. Yet it might stand almost without alteration in any detail for an illustration of the way in which the spermatozoon invades the ovum, repeating the performance which actually took place in the early history of all bisexual animal and vegetable natures. The origin of sex in fact was parasitism by one creature, which has become the male element, upon another, which is the female element. This parasitism became, as parasitism often does in nature, symbiosis or union of life; but in this case the union was consummated so far back in the evolution of the forms of life, that its repetition occurs with each generation in the processes which take place before the development of the typical embryo begins.

"If I say that I have no doubt whatever that the invasion of the ovum by the spermatozoon is a repetition of the actual attack made upon a one-celled amœba-like creature by a smaller parasitic protozoan long ago, I hope you will not think that my belief is based upon no stronger evidence than the resemblance which I have mentioned. It is based upon a large number of other facts all pointing in the same direction, and I really first stumbled upon the truth when I was seeking for the explanation of another phenomenon in nature, namely, the "alteration of generations." This, as you are doubtless aware, is the name given to the process by which certain creatures, both plants and animals, are made by life to appear quite different creatures in alternate generations. There is, for instance, a kind of vegetable growth which is something like a little liverwort but quite unlike a fern. It is called a 'prothallus'; but when life carries on the reproduction of the race, the next generation consists not of 'prothalluses,' but of ferns; and when life carries on the reproduction of the ferns the next generation consists not of ferns but of prothalluses.

"In the same way you find free-swimming jelly-fishes in the sea, which, where life causes them to reproduce their race, reproduce, not jelly-fishes, but little sea-anemone creatures which live a fixed life. And the children of these sea-anemone things are jelly-fishes again.

"It was in investigating this phenomenon that I discovered that it was analogous to bisexual reproduction, and that both were only advanced phases of symbiosis, as the living partnership which often results from parasitism is called. The lichen represents a phase in which the fungus and the alga upon which it was parasitic live together as the distinguishable factors of a single plant. The fern and the jelly-fish above referred to represent phases in which the partnership has become an arrangement by which the parasite and the host become 'predominant partner' in alternate generations. In bisexual creatures one or the other becomes the predominant partner in the composition of each individual. Valuable confirmation of this conclusion was found later in many facts, including the spermatozoon-ovum incident; but the theory does not by any means rest upon it."—*From a leaflet by E. K. Robinson, published in the English Mechanic.*

Measuring the Intensity of Light

Prof. J. T. Lundbye, in a paper read recently before the Danish Society of Engineers, gave an account of the various units of light used in European countries, and the intensity of light required for satisfactory illumination under various conditions. A simple method is given (*Ingenioren*, August 28) for obtaining the intensity of light by measuring the distance at which letters of known size can be read with different lights. Up to a certain point this distance increases very rapidly with the intensity of light, but when the intensity exceeds a certain limit the increase in distance is small. A pair of smoked glasses, which intercept a known quantity of light, and a decimal rule are the only apparatus required. The luminous intensity is found by measuring the distance at which a given specimen of print can be seen through smoked glasses, and then measuring the distance at which it can be seen without them. The ratio between these two operations forms a measure of the luminous intensity.—*Nature.*

The Chemistry of Flavoring Matters—II*

The Relationship Between the Constitution of a Body and Its Taste

By Francois Barral, of the University of Paris, and Albert Ranc, Laureate of the Institute

[Concluded from Scientific American Supplement No. 2251, Page 115, February 22, 1919]

III. FLAVOR IN THE ALCOHOLS.

The alcohols are of great importance from the point of view of the chemistry of the sweet flavors. It is in this class of substances that all natural sweetening agents are found. The taste of an alcohol depends entirely upon the number of hydroxyl groups (OH) present in the molecule. The compounds which contain only one such group are but faintly sweet.

When, on the contrary, we study the molecules containing four, five, or even more hydroxyl groups we observe that the sweet taste is very intense, and also that it is independent of the coexistence of the aldehyde ketone carboxyl and amido groups, which in all other circumstances profoundly modify the taste of the molecule when grafted upon it. Sometimes, however, when the sweet tasting molecule has attached to itself a heavy group, especially if the latter is aromatic, a modification of the taste may be observed. The same phenomenon may be observed when one or more hydroxyl groups are saturated by condensation with acids or with bases. The cyclic form exerts no effect upon the taste of the molecule; quinite, dambonite, and quercite are all sweet.

A. *Monoatomic Alcohols.*—The taste of the monoatomic alcohols is not constant. The influence of a single hydroxyl group is insufficient to furnish a predominant flavor. The halogen alcohols are sweet, the nitro-alcohols are bitter. The first members of the series of the aliphatic mono-alcohols are insipid or almost imperceptibly sweet; in the aromatic series, on the contrary, the sweet taste is found.

B. *Glycols, Glycerines, Tetra-atomic Alcohols.*—The sweet taste of the simple glycols diminishes in proportion as the molecule grows more complex. The glycols having many carbon atoms are bitter. A few rare members of the aromatic series are sweet. The glycerines are nearly all sweet. The presence of a heavy group in their molecule produces a bitter taste, as in the case of phenyl glycerine, for example. The existence of an aldehyde group, on the contrary, as in erythrose, for example, increases the sweetness of taste. The tetrols are all very sweet. Exceptions are octylerythrite and rhamnose, which are bitter.

C. *Penta-atomic Alcohols.*—These are all sweet, and the formation in a pentol of ketone or aldehyde groups augments this property; it is only necessary to cut out the keystone radicle or the aldehyde radicle of a body in this series, by forming an oxime, for example, to cause the intensity of the sweet taste to diminish very markedly.

D. *Poly-atomic Alcohols; Saccharides and Their Derivatives.*—The accumulation of hydroxyl groups in the molecule of a substance, starting with the pentavalent alcohols, results in a decrease of sweetness in the taste of the various compounds obtained. Sorbite, dextrotalite, *alpha* galaheptite, and scyllite are decreasingly sweet and galactite is almost insipid. In the series of the polysaccharides (saccharose, lactose, etc.) we again find the sweet taste, but in the case of the molecules which are much less complex, like glycogen and cellulose, for example, a total absence of taste is the rule.

To sum the matter up, in the series of the alcohols and of their derivatives having aldehyde or ketone groups the sweet taste arrives at a maximum which corresponds to the presence of five hydroxyl groups in the molecule. The intimate constitution of the sugars, which is thoroughly well known from several points of view, does not solve the question of the degree of sweetening power of the various isomers. If we examine the poly-alcohol acids we find the same sweet taste as in the corresponding alcohols. The internal anhydridization, so frequent in that class of substances, generally changes their taste. Insipid lactones and bitter lactones are both well known. The amido derivatives of the sugars retain their original flavor. The basic nature of the molecule exhibits itself by the caustic action upon the tactile organs of the tongue; this causticity is banished by combination with a hydracid, being transformed into a salty taste which is comparatively rare among organic compounds.

The glucosides, whose bitter taste has so frequently been found a striking feature by men engaged in research that they have given them characteristic names, such as "bitter principle of lycopod, convallamarine," etc., have some sweet substances among their constituents. Some of them, however, the methyl and ethyl glucosides, are sweet. We may mention as a remarkable exception populine which is sweet although derived from salicine, which is bitter, by the operation of etherification, which generally develops bitterness.

IV. TASTE OF THE PHENOLS.

In the class of the phenols both solubility and sweetness depend upon the number of hydroxyl groups contained in a molecule. The mono-phenols are rarely sweet, their action upon the tongue consisting chiefly of a tactile sensation. However, the sweet taste is developed in this class of bodies with the introduction into their molecule of the methoxy and azo-imido group, and this independently of their position.

The same fact has been noted previously in the case of nitro-benzene.

The di-phenols and tri-phenols of the meta series all possess a sweet taste (Resorcine, orcine, dioxy-pyridine). The same thing is true of the para series (Hydroquinone, chlorohydroquinone, dihydroquinone). The simple ortho, di, or tri-phenols are bitter (pyrocatechine,[17] pyrogallol). Among the more or less complex substances we find sweet substances such as luteoline, brasiline, hematoxyline.

In short, whatever the position of the hydroxyl group may be the taste of the phenols tends to increase in bitterness in proportion as the molecular weight increases. An analogous phenomenon has already been pointed out in the case of the glycols and the glycerines. The introduction into the molecule of a nitro group injures the sweet taste. Thus, nitro-resorcine and nitro-hydroquinone are scarcely sweet at all and nitro-phloroglucine is distinctly bitter. The halogens also destroy the sweet taste of the phenols, and chloro-resorcine is not sweet, while iodo-resorcine is bitter. The aldehyde group has the same property, the 1—2, 1—3, 1—4, oxybenzaldehydes not being sweet.

V. THE TASTE OF THE ORGANIC ACIDS.

The organic acids have an acid taste whenever they are soluble in water, and the smaller the molecule the more acid the taste. This fact, which is connected with the presence of the carboxyl group, and which is independent of the constitution of the molecule, obliges experimenters to taste these substances in the state of salts of sodium, which have not the acid taste nor the flavor peculiar to the sodium ion. This acid taste is also made to disappear by anhydridization. Furthermore, very few anhydrides of acids have any taste, and the sweet taste of the pyro-tartaric, pyro-cinchonic, and methyl-ethyl-maleic anhydrides forms a remarkable exception.[18] The acetic-oxime-acids are extremely sweet.[19] This taste is a specific characteristic of the introduction of the acid group; the insipid oximes[20] such as that of para-methoxy-aceto-phenol furnish a very sweet derivative upon the introduction into their molecule of the group—CH^2—COOH.

Acetic isobenzaldoxime is the only isomeric compound of this class which has been tested. It is quite as sweet as the normal benzaldoxime. However, there is an essential difference of constitution between these two substances, the acetic residue being attached to nitrogen in the isomeric derivative and to oxygen in the normal derivative.

The influence of the sulfonic group upon an organic molecule is not very definite. Pseudo-cumene, methyl-iso-propyl-benzene and camphor are the sweet sulfonic compounds, while those yielded by phenanthrene and anthraquinone are bitter. In some cases sulfonation causes the sweet taste of a substance to disappear; thus the dulcine sulfonate of soda no longer has a sweet taste. Finally, we must mention the curious peculiarity of the barium salt of the sulfonic methyl-iso-propyl-benzene acids, one of which is sweet while the other is bitter.

VI. TASTE OF THE ETHERS.

In the category of the ether-oxides the etherification generally interferes with the sweet taste if the latter be due to the presence of an etherifiable hydroxyl group. Thus, methyloxi-glycol is not sweet, as glycol itself is. If the sweet taste, on the contrary, is not due to the presence of a hydroxyl group, but to that of groups such as —NO^2, = N—OH then the taste of the substance is not changed by etherification. Ortho-nitranisol, para-anisaldoxime are sweet. There are some exceptions to this rule, however, since diethyldioxyacetone, for example, is sweet, although this taste belongs to the etherified hydroxyls of dioxyacetone.

Among the simple ethers, which still contain hydroxyls, we find many sweet compounds (dimethylacetal glucose, etc.) the halogen ethers are nearly all sweet. Anethol and estragol are sweet phenolic ethers.

The ether salts often have a taste with a tendency towards bitterness, different from that of the corresponding alcohol and acid. Only three sweet ethers derived from bitter alcohols are known, namely, the acetate of 2 bromo-ethyl, carbonate of pyrogallol and populine.

VII. TASTE OF THE AMIDO ACIDS.

Glycocol, or sugar of gelatine, owes its name to its sweet taste, which has long been known. It is the prototype of the amido acids. Among these bodies the alpha amido acids are sweet in a very general and pronounced manner, to such a point that the attaching of their molecule to an aromatic nitro residue, which nearly always interferes with the sweet taste, in no way modifies these compounds. Thus phenylamine and its chloro, bromo, nitro and amido derivatives are all sweet. The alpha-amido-hydroxyacids are also sweet.[21] The three alpha-amido acids are somewhat less sweet than those of the amido series in the alpha position. In the class of the amido acids connected with the group of sugars the position of the amido group seems to have no influence on the sweet taste of the molecule.

The fatty di-amido-acids are not sweet. The acids with nitro nuclei, pyrazols, pyridine, quinolin, are bitter with the exception, however, of the iso-cinchomeronic acid and the 1 amido —3 bromo —2 pyridone carbonic acid.

The peptids, inversely to the alpha amido acids, are insipid or bitter. In the tryptophane series some sweet peptids are found. It should be noted that among all these bodies it has been frequently found that a relationship exists between the taste and the molecular special structure. Among the amido-solfonic acids the triazine is of particular interest because it contains glucine which is a commercial sweetening agent in the form of a mixture of a sodium salt of the di- and trisolfonic acids of the base obtained by the action of the benzaldihyde upon the diamido-nitric derivative.

VIII. TASTE OF THE AMIDORS AND OF THEIR DERIVATIVES.

The amidons are bitter, especially those of the aromatic series. Some of them, however, have a sweet taste due to their halogen or to their hydroxyl group or to the amido-acid complex contained in their molecule (dextro-asparagine, diacetamide erythrose, perchloro-cyano-propion-amide). In the group of the ureas several interesting sweet compounds are found, the principal one being para-ethoxyphenylurea, otherwise sucrol or dulcine, which has been employed as an artificial sweetening agent. The study of the changes of taste corresponding to changes of constitution in this substance has engaged many investigators, who have shown that nearly all the modifications to which the molecule of dulcine is subjected destroy the sweet taste; only the introduction of the amido-group is without influence.

Only a few sulfamides have been studied with respect to taste. Among those which have been tasted the only sweet one is dimethyl-sulfamide. The group of the sulfamides is very small but one of its members, saccharine or benzoic sulfimide, gives it considerable importance.[22]

It is unnecessary to lay stress upon the well known sweetening power of this compound except to note that slight molecular changes cause it to disappear. The replacing of the imidic hydrogen of saccharine by an organic residue (methyl, ethyl, CH^3 OH, C^6H^5) produces insipid bodies.

The same thing is true of the introduction of any group whatever into the benzenic nucleus or of the

*From Revue Scientifique.

[17]Guayacol, a methyl derivative of pyrocatechine, is sweet as being a methyl ether oxide of monophenol.

[18]Observe that these bodies, which contain neither hydroxyl nor replaceable hydrogen, are not acids; their analogy with the imides, and hence with saccharine, should be noted.

[19]G. Cohn (loc. cit.).

[20]Most of the oximes are sweet; we have already pointed out the influence of stereo-chemical structure on these bodies.

[21]The organic bases are all bitter (amines, hydragines, cyclic bases, pyridine, quinolein, alkaloids). This fact is remarkable, for the amido group has no effect on the taste of saccharine and dulcine, and when associated with the carboxyl group it usually gives sweet bodies.

[22]French industry has successfully produced saccharine for a twelvemonth.

opening of the closed lateral chain. An exception is that the attaching of the amido group to saccharine does not alter the taste. Chlorination on the contrary produces a bitter taste.

IX. CONCLUSIONS.

If we examine in their totality all the facts which we have just set forth certain observations are inevitable concerning the influence of variations in molecular constitution upon taste. It seems to be well established, for example, that the introduction into a sweet molecule of any radicle whatever, but especially of an aromatic one, results in the destruction of the sweet taste and the obtaining of a body with a bitter taste. The heavier the radicle introduced the more clearly marked will be this modification. Nitration causes the disappearance of the sweet taste. The same thing is true for the formation of the halogen derivatives, except, however, in the class of the hydrocarbons, in which the introduction of the halogens, and especially of chlorine, causes the sweet taste to appear.

The influence of an alcoholic radicle is more complex. The alcoholization of an amido group causes the appearance of the sweet taste. But it makes it disappear when it concerns an imido group or a hydroxyl group.

The amido group does not affect the sweet taste. The sulfonation of a compound seems to have a tendency to cause the appearance of the bitter taste. Acting differently, the methoxy group introduced into an aromatic molecule produces the sweet taste and changes the bitter taste to sweet. The ethoxy group does not exhibit the same property. Finally, it is interesting to note that in the same family of substances, other things being equal, the taste tends to become increasingly bitter in proportion to an increase in the weight of the molecule.

Upon the whole our knowledge as to the tastes inherent in organic compounds is confined to a series of comparisons of more or less general character. We know almost certainly that the poly-hydroxyl bodies and the alpha amido acids are sweet and that the polynitro bodies are bitter, but in each of these classes there are cases which escape the general rule. These anomalies, which are especially frequent in those classes of substances with very complex molecules, appear to depend upon the proximity of the groups and the unknown relationships which are established between them. Sternberg[23] attributes very hypothetically to the "harmonic" arrangement of certain groups (hydroxyl and nitro) in a molecule the power of causing a definite sweet or bitter taste. However this may be there are groups (hydroxyl, nitro) which are incapable of imparting any taste by their presence singly; but they assist in the development of a case, or even create one by their multiplication or by their proximity with other groups; they might be called "sapophores" (taste bearers). And certain groups are in themselves "dulcigenes" or "acidogenes" or "amarogenes" (sweetness, acid, or bitterness bearers).

It is impossible to be more definite than this. At present we possess along this line only an accumulation of facts which lack a directing principle to bring order out of them. For further information we refer the reader to the bibliographic and personal researches of G. Cohn.[24]

* * *

While as we have seen we have been able to extract a few laws from the mass of information whose methodical exposition we have here attempted, we are still far from the establishment of a general law which would enable us to deduce the elementary taste of a body from a knowledge of its molecular structure.

However, a similar problem has existed with regard to all the properties of bodies, and when its solution has been found possible it has always yielded interesting results. There have been observed, especially in the case of the physical constants, certain cases of an "additivity" of properties which permit us to consider the expression of a characteristic property of any compound as being the sum total of the properties of its elements united in a simple mixture. This fact has been observed, for example, in the case of volume and molecular refraction. These are only special cases, for the contact of the atoms combined in a body does not consist of a simple proximity as in a mixture. There are physical properties such as the absorption of light, optical activity, the point of fusion, in which the mutual influence of the atoms upon each other is very evident. Other physical phenomena depend upon the relations between molecules and even, at times, between molecular weights.

The study of the functioning of the sense of sight has been greatly advanced by the knowledge of the relationship which exists between the constitution of bodies and their selective absorption of light. The color of a substance depends upon this absorption, or, to speak more precisely, the property which a body possesses of causing a certain sensation of color is a function of its absorbent power with respect to certain luminous radiations, and this power bears a definite relation to its constitution. This precision of language is made necessary by the confusion which exists between the property which belongs to the body and the sensation which belongs to the individual. For in the course of a long and slow series of adaptations the sensations projected outwards have come to be considered as properties of the body itself.[25] In the case of sight the dissociation between these two elements, the internal and the external, is very clearly marked. The property belonging to the body, which is the result of its molecular structure, makes a selection, so to speak, among the vibrations of light thus choosing the photochemical agent which will act upon the retina to cause the sensation in the brain.

In the case of the sense of taste the affair is not so simple. There is an immediate contact between the substance and the sensory apparatus, and this interferes with the analysis of the mechanism of the action of bodies possessing flavor. Continuing the analogy with the sense of light we may say that the vibration which issues from the substance, and impresses the papillae concerned in taste, is not known to us, for it is impossible to follow its path and to arrest it and study it during its passage.

The study of luminous vibrations has been facilitated by photometry, by optics, by the spectrograph and by the use of the sensitive plate which, so to speak, makes a permanent record of the results of the optical properties of bodies.

But the agent which excites the action of a sense of taste cannot be arrested externally nor simplified nor selected, for it has its birth at the time of contact of the stimulating substance and the sensory cell, and its action occurs simultaneously with its formation. It is the result of a reaction between the flavor bearing body and the specially organized substance concerned in the sense of taste. This body has the property of flavor, we may say, because its chemical constitution and that of the papillae of the tongue permits of a chemical combination whose result excites the gustatory nerves. Hence it is obvious that the quality of flavor is not a measurable property easily expressed by a figure, as is a physical property, for in the present state of our knowledge we do not possess any perfectly lucid and evident method of representing the phenomenon of chemical combination, and it is this ignorance which prevents us from forming an exact theory with regard to the conditions governing flavors. To these theoretic impossibilities, which are doubtless only temporary, we must add the numerous technical difficulties with respect to experiments concerning taste.

The functions of the mouth are various, and the diverse impressions received in its different areas form a totality which is sometimes inextricably confused. The taste of a body varies with its degree of dilution in water or in saliva, and is disturbed even by mere traces of impurity; the sensation of taste which its flavor produces may also be influenced by the state in which the gustatory cells have been left by previous stimuli. Moreover, whatever the nature of the sensations experienced, it is only a notation of the mind, whose nature is unknown to us. It is the sign of an object, a sign which may be recorded objectively by the science of physics, by whose apparatus our senses are extended and improved. This is true of sensations of color, for example, but there exists nothing similar for the sensation of taste, whose determination by reason of this very fact is subject to all the errors of subjective illusion. Does this mean that we shall never be capable of comprehending the relations existing between a savory body and the taste which it excites. Not so, but it is probable that the problem has been prematurely stated. Doubtless the progress of general chemistry and of physico-physiological experimentation will one day permit us to comprehend the nature of the phenomena which cause a given taste to correspond to a given molecular structure. The poverty of the sense of taste, which has only four categories of flavors by which to classify the multitude of bodies which excite the sense of taste, is only too apparent. The elementary flavors, sweet, bitter, acid and salt, may be considered as collections of delicate gradations of perception bearing a relationship to the infinitely minute modification of the molecular structure of substances possessing flavor. Thus we may conceive of tastes as representing an ensemble of physical and chemical properties which are partially unknown to us, in analogy with the conceptions we have of sounds and sights.

When we have obtained a more exact knowledge of physico-chemical phenomena, the anomalies we have mentioned will doubtless disappear and some new law which will differ, perhaps, from the one which we now accept will give entire coherence to the relationships between molecular constitution and taste. Even today every effort to solve these problems will have the practical result of guiding the researches made with regard to artificial sweetening agents, and will assist in solving a problem which involves at one and the same time chemistry, physiology and psychology.

[23] Arch. für Physiol. 1898 and after.

[24] G. Cohn (loc. cit.).

[25] Flavor and taste are usually employed as if having the same meaning.

Electrochemical Behavior of Nickel

In recent years it has been shown in the Amsterdam Laboratory that one of the most characteristic properties of a metal is the velocity with which it assumes electromotive equilibrium at a definite temperature and pressure. At the ordinary temperature and pressure this velocity is very small for the metal in the dry condition; in contact with an electrolyte, however, the velocity is quite different, although complications are then caused by the appearance of catalytic actions, both positive and negative. These catalytic actions make the comparison of the behavior of different metals a difficult matter, as has already been shown in the case of iron immersed in different electrolytes.

Some metals, however, assume internal equilibrium very slowly in contact with an electrolyte, and nickel is one of these. With this metal, not only oxygen, but also hydrogen, acts as a negative catalyst, and the catalytic effect is very pronounced. For example, when hydrogen at a pressure of /atmo. is led through a solution of nickel sulphate in which Ni electrodes are immersed, the equilibrium is disturbed either in the base or noble direction until the electron concentration of the metal equilibrium becomes equal to that of the hydrogen equilibrium in the electrolyte. It can be shown that in this case the p.d. of the Ni with respect to the electrolyte, not taking into account the volta-effect, must become equal to the p.d. of the hydrogen electrode; experimentally it was found that practical equality of these two p.d.'s exists.

It is shown by theoretical considerations that the unary equilibrium potential for Ni is only to be expected in an atmosphere free from oxygen or hydrogen, or in a vacuum, and when a solution of a nickel salt is used in which the hydrogen concentration is less than 10^{-3} for a nickel ion concentration of 1. Experiments made in accordance with these theoretical considerations gave —0.480 volt, with respect to the normal calomel electrode, as the equilibrium potential, which value agrees entirely with that calculated by Wilsmore and also with that found by Schoch in an experiment in a vacuum. It is pointed out that in the many potential measurements of Ni which have been carried out in the air or in a hydrogen atmosphere, the equilibrium potential of the unary Ni has not been measured, but rather the potential of a state of this metal which has been disturbed in a base or noble direction.—*Note in Sci. Abts. on a paper by A. Smits and C. A. L. de Bruyn in K. Akad. Amsterdam.*

Pigment for Printing Inks

Printing inks may be divided into two classes, *viz.*, "litho" and "letterpress." The pigments used for the former class must be completely free from acidity, quite insoluble in water, possess good "solidity," moderate transparency, and not too high a specific gravity. Those for use in the manufacture of letterpress inks must be brilliant and opaque and when for use in process of three-color work have low specific gravity. Printing ink pigments are preferably composed of dyes fixed on alumina, either alone or co-precipitated with *blanc fixe*, the lake and mineral pigments being simultaneously precipitated. Barytes or other abrasive material is quite useless as a base for either class of ink. The desiderata of a good printing ink pigment are principally brightness and strength, the latter property ensuring that sufficient printed impression will be obtained by the use of a very attenuated film, thus guarding against liability to "set-off" on the adjacent superposed sheet. Other properties of the pigment are required for special purposes, *e. g.*, transparency and resistance to heat for tin-printing pigments, insolubility in alcohol for labels which are subsequently spirit varnished, resistance to alkali for use on soap wrappers. A classification into degrees of fastness to light and the adaptation to different purposes of pigments of varying stability to light, alkali, etc., is given, *e. g.*, the special suitability of a fugitive, water- and spirit-soluble pigment, non-resistant to acid and alkali, for printing on cheques, etc.—*Note in J. Soc. Chem. Ind., a paper by T. M. Tyson before the Oil and Color Chem. Assn.*

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Pork and beef come from every State in the Union

A cooling room that holds thousands of dressed hogs

America's Food Resources

The illustrations on this and the following page are simply reminders of the wonderful resources of our country, without which the war could not have been carried on successfully and brought to a satisfactory conclusion. The burden of supplying not only the armies of the allies, and our own, but also the civil population of the allied countries was not thrown on America solely because of its great resources, for other regions, such as Australia and South America, were in a position to furnish great quantities of food, but because it was nearest and there were not enough ships to enable the necessary supplies to be brought from far distant sources.

The supreme crisis has passed, and the desperate conditions that threatened if the war had continued another year have fortunately been avoided; but there is a lesson in the occurrences of the last two years that apparently has not been fully recognized, and that is that in the future it behooves us to take more careful forethought in the conservation of our food resources, and to put more intelligence into their efficient utilization. One of the most important chapters of this lesson, and one that should be brought home to every household, is the desirability and advantage of broadening our menu, which at present is ridiculously limited in view of the great number of products that might easily be available if a reasonable demand existed.

Broadly speaking, the bill of fare of the average man comprises only about a dozen different materials, although prepared in various ways; and, taking the products of the land as an example, this limitation concentrates the demand on a few staples that, on account of soil and climate conditions, can be grown only in certain sections of the country. As the tendency is for population to increase faster than production, such a concentration of demand reacts to the disadvantage of the consumer.

In meats there is little possibility of an increased variety; but in fruits, vegetables and grains there are great possibilities, as is constantly being demonstrated by the work of our Department of Agriculture, to whose valuable work far too little attention is paid. It has repeatedly been shown that there are in various parts of the world a very great number of valuable agricultural products that might be successfully grown in the United States, often in regions that are not at present being practically utilized; and if our people could be induced to venture out of the very contracted circle that circumscribes their daily regimen and adopt these, to them, new food materials the results would not only be gratifying to their palate, but relieve the constantly growing demand for the old staples.

In this connection it may be recalled that geography and climate are important factors in the newer agriculture, for it is being recognized that local conditions should be carefully considered in deciding not only what products can be most successfully grown, but what particular variety of plant, wheat for instance, will give the highest yield in the district in question, for it is one thing merely to grow a certain grain in a partcular locality, but the most suitable variety in point of yield is an entirely separate and important problem. This has been clearly indicated in a recent paper that appeared in these columns.

Another phase of the food question relates to fishes, for at present habit and custom is restricting us to only a few of the available varieties to the neglect and exclusion of a considerable number equally wholesome and desirable; but, as in many other matters of this kind, the dealer follows the line of least resistance, and it is difficult to induce him to take up any commodity that will not sell itself. Here is where an intelligent public that keeps informed in regard to what our Government Departments are doing in the way of food investigations can exert a beneficial influence on our food purveyors.

Preserved food by the million cans

There is still another direction in which it would seem that a revision of methods is desirable, and that is the conduct of our national charities. Heretofore, influenced by the knowledge of our bounteous resources, we have prodigally responded whenever there was a shortage of food in any other country in the world. Whenever there has been a suggestion of such a condition, there has always been a host of hysterical people, and others eager for notoriety, ready to start a philanthropic movement, usually at the expense of other people; and the press has always been prompt to take up the work, as charitable movements make good headlines, and appeal to the neurotic tendencies of the crowd. While charity, rationally conducted, is entirely commendable, there is no good reason why the burden should always be assumed by America, to the exclusion of all other great food producing countries, and it is high time that other nations should provide for their own dependents. In this connection it may be suggested that the limit has been decidedly strained by the suggestion that the United States should feed Germany. To bolster up this proposal it is asserted by politicians and sentimentalists that the war was solely against the ruling classes and not the German people. The fallacy of this statement is evident when we consider that the German army was composed of the German people, and when we consider the diabolical brutality of detail with which these men elaborated the ruthless policy of their leaders, the attitude of the German people is clearly evident. Furthermore, during the war Germany has drawn immense supplies from the territories to the East, Roumania, Bulgaria and Turkey, and there is no reason to suppose she cannot still rely on these sources, particularly as she systematically developed the resources of these regions and took good care that production did not cease.

The surplus supplies of the United States have been entirely absorbed during the last four years, and it will be a long time before conditions return to normal, if they ever do, especially in view of the fact that with the greatly inflated earnings of a large class of our population a corresponding increase in the demand for food has resulted. And another fact to be remembered in our future study of food conditions is that, during all the period of scarcity and high prices in this country, the prices of American produced food abroad has been lower than in our own country, and in many instances the quality has been better than obtainable in this country.

Differentiation of Natural and Artificial Silks

A physical method of differentiation is described which is based on the differences between the refractive indices and which is applicable in the case of dyed fibers. A fiber of natural silk mounted in aniline and examined under a microscope with a Nicol prism is almost invisible when its longitudinal axis is at right angles to the plane of polarization of the prism, and becomes more and more visible when the stage is rotated, until it reaches a maximum of visibility at right angles to the original position. Artificial silk fibers have a refractive index considerably below that of aniline and are distinctly visible at all positions of the revolving stage.—*Note in J. Soc. Chem. Ind. on an article by A. Herzog in Kunststoffe.*

Harvesting our grain on a Western farm

Shipping our food abroad at the city docks

Stripping Negatives for Storage as Gelatine Films

THE conditions for the supply of dry-plates have naturally turned the thoughts of photographers towards methods which may be employed for returning the stipulated quota of glass while retaining in their possession such negatives as they judge will be of value from the point of view of re-orders. In ordinary times one would not recommend as a working system the stripping of the negative film from its glass support and its preservation in the form of a thin sheet of gelatine without other support. But it can readily be understood that many studios may be so circumstanced as to find it desirable, if not necessary, to adopt such a plan as this; and therefore it may be of interest to say something on the practical means which may be adopted to this end.

The stripping of a gelatine film from its glass support is by no means a difficult business, and the process which for some years past we have regularly recommended in the "Almanac," namely, that of Holcroft and Middleton, is one which is thoroughly reliable. But it is slow, it is not adapted for the stripping of films which are to be preserved as such, and, further, it demands the use of methylated spirit. On these three different accounts it is not a method which can be usefully applied for the purpose now under consideration. Instead, it is necessary to employ a process in which the gelatine film is thoroughly tanned before removal from the glass; that is to say, so hardened that it can be handled and stored as a thing by itself without fear of being damaged under such reasonably careful treatment as so delicate an article requires. For this purpose the most suitable method is a modification of one of which very complete working details were given some time ago by Mr. R. B. Fishenden, of the Manchester College of Technology, by whom it was worked out. In this process the gelatine film is first hardened in a bath of formaline and then detached from the glass by means of a similar bath of formaline, but containing also hydrofluoric acid. The advantage of the process from the point of view of those who may require to treat considerable numbers of negatives by it is that negatives may be treated in batches in the plain formaline bath, while the action of the second bath, containing hydrofluoric acid, is rapid. It should be said that we would not claim for the process a degree of reliability which may be ascribed to the Holcraft-Middleton method, meaning by "reliability" the power of the process to strip with certainty even negatives which are of considerable age, and may have become horny and hard with time. But we do not think that any inferiority in this respect need trouble photographers in the present circumstances, since from the nature of things the negatives to be treated will be those of comparatively recent date, and will not have become hard and horny with time.

The first step in the process is to cut through the gelatine film to the glass with a sharp rigid knife close to the four edges of the plate in order to cut away any emulsion coating which may be adhering to the edges of the glass. The plates are then immersed in formaline, the commercial liquid as purchased, for ten minutes or so. The formaline bath may be placed in a grooved tank, and is best used in a tank, not only on account of handling a number of plates at once, but also because the vapor of the formaline can be more or less prevented from escaping by means of a lid on the tank. After this first treatment, during which the gelatine film becomes thoroughly hardened, the plates are transferred, or only so many of them as can be expeditiously handled, to a similar bath of formaline to which commercial hydrofluoric acid has been added in the proportion of 2 per cent.; that is to say, ½ oz. of the acid to 25 ozs. of the bath. This second bath should be used in a vulcanite dish. It is necessary for the negative to remain in this second bath only for the matter of 20 seconds or so, after which the negative is removed from the solution, given a rinse under the tap, and the narrow edgings of gelatine then stripped off. It is then given a further short wash in order to remove traces of acid. This washing is best done in a flat dish into which a gentle stream of water is led; washing in a tank, particularly with any vigorous flow of water, is liable to disengage the film from the glass prematurely.

The negative is now in a condition to have its film removed from the glass, which is done by laying upon it a slightly larger sheet of tough paper, such as good writing paper, previously soaked in water. The paper is brought in firm contact with the negative by careful use of a squeegee. Undue action of the squeegee must be avoided, otherwise the negative is liable to be distorted. A corner of the paper is then raised, and a thin pointed knife used to ensure the corresponding corner of the negative adhering to it. This being so, the paper can be removed, carrying the gelatine film with it.

Grain from the ranch to the railroad

In order that the film may dry without shrinking or distortion it is necessary to have it upon a glass plate, and a supply of such plates sufficient for dealing with a batch of negatives dealt with at a time requires to be kept. These plates are thoroughly cleaned and polished with French chalk, as is done when using them for the glazing of prints. The gelatine film, still thoroughly wet and adhering to the paper, is then brought down upon a clean glass plate, and, again by means of a thin pointed blade, the paper is removed, leaving the film upon the glass. The film then requires to be left to dry slowly. Any hurried drying is certain to lead to crinkling of the film, and for the same reason it is necessary to avoid drying in a place where there are irregular currents of air. The best plan is to lay the glass plates exposed to the air of a moderately warm room, the windows and doors of which are closed. Those who may have had occasion to dry the now perhaps forgotten Cristoid films will recognize the need of this precaution, although the ordinary film of a negative is thin in comparison with that of a Cristoid film, and dries in a correspondngly lesser time and with less liability to distortion. When the film is perfectly dry it is peeled off the glass, and can be kept in its then flat state by storing it where it will be subjected to a certain amount of pressure. One or two other hints may perhaps forestall any difficulties which may be found in this process. One is that negatives which may have been handled with greasy fingers should be first cleaned up by rubbing over the surface with benzene applied with a tuft of cotton wool. Negatives which have not been too heavily treated with retouching medium will strip readily, and some experience with existing negatives will show what amount of retouching they may carry without leading to difficulties in stripping or necessitating the removal of the retouching before the process. In the event of negatives being required for further prints, the film negative can, of course, be supported in the printing frame like one on celluloid film, while if it has been necessary to remove the retouching medium calling for further retouching the negative will require to be soaked in a 1 per cent. or 2 per cent. solution of glycerine before being squeegeed down upon a glass plate which has been flowed over with a weak solution of gum, this coating serving to hold the film to the glass, and thus making it practicable to carry out any retouching work which could not readily be done upon the negative in its film condition.—*British Journal of Photography.*

The Grass Tree Resins of Australia

AT a meeting of the Sydney, Australia, Section of the Society of Chemical Industry the retiring chairman, Mr. Henry G. Smith read a paper on the "Grass Tree" resins of Australia, and the possibility of manufacturing picric acid from them. The fourteen varieties of "grass tree" (*Xanthorrhœa*) found in Australia are distributed irregularly, and some of them are of considerable size. The yellow resin from *X. hastilis* is most in request, and it has been collected from time to time in considerable quantities in New South Wales. This species is not now nearly so plentiful as it was, because the "grass trees" grow so very slowly, and when once cut down in the process of collecting the resins the tree is destroyed. Most of the resins from the other species are red in color.

It was found that a fairly constant percentage of picric acid could be obtained from resins collected from the same species growing in localities wide apart. The greatest yield of picric acid formed from any of the resins was 50 per cent. with the product of *X. hastilis; X. Tateana* gave 46 per cent.; *X. Preissii* 23 per cent.; a species common in Queensland 23 per cent.; *X. australis* from Tasmania 18 per cent.; a narrow leaved form growing in the Ranges in the interior of New South Wales 18 per cent. With a red resin from (?) *X. arborea* only 5 per cent. of picric acid was formed. It was found necessary to use at least 12 parts by weight of nitric acid to one of resin, so that the quantity of acid required to be used would be considerable, and about six times the amount necessary to obtain the same weight of picric acid from phenol. Grass Tree resins are used in the preparation of spirit lacquers, varnishes, sealing wax, and for similar purposes.

Prior to the war steady shipments of "Grass Tree Resin" went forward from Australia to Europe; in the six years prior to 1915, 1831 tons of gums and resins were shipped to England of an average value of £8 per ton, and 4,826 tons to Germany of an average value of £7 6s. per ton. The greater proportion of this was "Grass Tree Resin." There are in Australia very large quantities of "Grass Tree Resin" available, for which other uses may eventually be found.

Packing Goods for Shipment*

How One Company Has Solved Important Commercial Problems

By Chas. M. Ripley, Publication Bureau, General Electric Company

ALTHOUGH the following account tells of the experiences and the methods of only a single large manufacturer it is so full of suggestions, and matter for thought, that it should be read by every man who is contemplating foreign trade; and it clearly sets forth a lesson that every business man must, sooner or later, learn. Improper and inadequate packing is the rock on which many an enterprise in export trade has been shipwrecked, as the result of ignorance or narrow-minded perversity, and this article clearly points the way by which such disasters may be avoided. This is an era of reconstruction of business methods, as well as other things, a time for awakening and a revision of out-of-date practices that have enabled other nations to so far outstrip us in world commerce.—Editorial Note.

Would it occur to you that electrical machinery for the west coast of South America would have to be packed differently for that for the east coast? Nevertheless, experience has shown that entirely different arrangements must be made because of the undeveloped facilities of many of our southern neighbors.

Machines for the west coast must be "dismembered" into numerous small packages of comparatively light weight, because there are no wharves, piers, or docks worthy of mention on the entire west coast. And besides, a burro cannot carry up into the Andes Mountains a package weighing over 170 lbs., while a mule's limit is 350 lbs.; so that electrical apparatus must be "knocked down" before being sent on such a long and arduous journey.

Just think of the preparation necessary to insure safe delivery of electrical machinery to many parts of South America! Transportation is by railroad to New York, by boat to South America, and from the boat into canoes. These canoes are paddled as close as possible to shore, and the boxes or packages of carefully made electrical machinery are tossed into the surf. They are then dragged ashore and trucked to a railroad station, and begin a rail journey of from two to four days, probably on an open or flat car, to the end of the line near the foot of the mountain; then for four days or more in an open boat, rain or shine, with Aztec Indians or peons as pilots. And then after the river ceases to be navigable, the Yankee motors and generators are loaded on the backs of mules for their journey up the narrow winding rocky paths of the Andes Mountains. Do you think that the Aztec Indian is careful to lower the package of precious machinery gently from the mule's back to the ground? Our Indian friend is probably as tired as the mule and merely loosens the strap, allowing the box to fall to the ground, whether it be rocky or marshy, whether the sun be shining or the rain falling.

To appreciate these difficulties remember that salt water as well as fresh water has been encountered, that the machinery has risen from sea level in a tropic land to the snow-capped mountains of the Andes, and that after arriving at the location of the power house it is likely to be left lying on the mountain side for months before the engineers are ready for it.

But the experts of American industry have learned how to pack the machinery to defy breakage, rain, and moisture; and they can guarantee in advance that the machinery will operate without a hitch.

And other problems must be solved, even on the better developed parts of the west coast of South America. In some places the machinery is lowered into lighters to be taken ashore. In spite of its name, the Pacific Ocean has many a rough sea, and you may picture a load of several tons of generators or motors being lowered from the vessel to the lighter, the lighter coming up on the crest of a wave with practically irresistible force. The size and weight of packages must be so limited that the men handling the derricks are able to safely land the machinery in the lighter, and not permit it to go crashing through the bottom into the sea.

In India crude trucks drawn by oxen carry loads as heavy as three to five tons, and the elephant can haul ten tons. In a recent installation of Yankee machinery in India, one year was required to carry the apparatus 250 miles into the interior by elephants. A curious sight was witnessed when the Hindus organized committees of welcome, with bands of native musical instruments, to meet the Yankee engineers; for the story had been spread that the Americans were to introduce that weird god of lightning which would lighten labor and pierce the night of their wilderness country in the Himalaya Mountains.

In India, just as in South America, the jarring of loading and unloading must be guarded against; but besides this there is in India a different enemy of electrical machinery who is most formidable, although he is only three quarters of an inch long from stem to stern. This enemy is the dreaded termite.

If a box of machinery were left overnight unprotected on a truck, the next morning there would probably be nothing remaining of the entire shipment but the bare metal. The termite is an insect which feeds chiefly on wood and does not leave even as much as sawdust after he has completed his meal. On one occasion a row of telegraph poles was completely eaten up by these termites and in 48 hours nothing was left but the wires and the glass insulators.

Engineers have found that coal tar is repulsive to the termite, so that all boxes for India are heavily coated with coal tar in much the same fashion as it is spread on the roof of a building.

On this 250-mile journey to the Himalaya Mountains in India, it was found that many of the bridges had to be rebuilt in order to carry the heavy loads, the equal of which had never before passed so deep into the heart of the country.

Now let us turn from the elephant of India to the dog sleds of Alaska—at almost opposite ends of the earth. Electricity is needed in the frigid zones as well as in the torrid zones, and the dog of the Eskimo is the accepted means of transportation in these northern latitudes. One thousand pounds is the limit in weight of each package in order that it may be effectively handled by a standard dog train. So well does the shipping expert comprehend the peculiar local conditions that special horns are provided on each package to assist the Eskimos in lashing the packages to the sleds. Thus the men of the shipping department must understand the customs and environment of the Hindus in the Himalaya Mountains, the Indians in the Andes Mountains, and the Eskimos in the Yukon District of Alaska.

That the development of the art of shipping has kept abreast of the development of the electrical industry itself is very well shown by the following instances:

When the first great turbine was built in Schenectady, in 1902, to be shipped to Chicago, it caused great perturbation in the shipping department. Two railroad cars were broken in attempting to load one of the cases; the railroad company deliberated for a week before it could decide whether it could transport the turbine to Chicago, and a special train requiring an extra expense of $1,000 in addition to the regular freight charges was necessary to get this piece of apparatus to its destination.

The Company has arranged for special cars of unusual strength, with increased depth reaching down to within a few inches of the rail, and otherwise adapted for the peculiar variation in size, shape, and weight of modern electrical machinery.

The art of fastening these large pieces of machinery to a freight car has been developed to a high degree of perfection. In a recent wreck on a western railroad the car containing General Electric aparatus was upset; but when the wreck was cleared, it was found that the platform of the car and the aparatus were still integral, the platform having left the trucks but remaining fixed immovable to the apparatus.

Here are some interesting examples of overcoming seeming impossibilities. When the large generators for the Metropolitan Street Railway were to be shipped to New York City, it was found that the loaded car would be one and one-half inches too high to clear the bridges. It was therefore necessary to give the springs of the railroad cars a special compression at the factory in order to permit the cars to get through. This heroic method overcame the contention that "It can't be done."

And there are many wonderful stories to be told of single turbines that require 15 separate cars for shipping; of special cars carrying from 50 to 70 tons each; and of how the aparatus has been so nicely poised and balanced on the car that clearance between the sides of the tunnels or bottom of the bridges has been figured out to one-half inch. In such nice calculations as these it has been necessary to abandon the use of wood for boxing, substituting sheet metal to obtain a covering thin enough to avoid crashing into bridges or scraping the sides of tunnels in the Rocky Mountains, as either occurrence would probably wreck the entire train.

When some of the big water turbines were to be sent to a power plant in the Rocky Mountains, there was a man in Schenectady who knew of a weak bridge in Minnesota, a low bridge in Montana, and a narrow tunnel in Idaho, and he knew just what the limitations were, and which railroad would be best for the shipment. Some apparatus for New England is shipped by way of Scranton, and taken by water to its final destination, because the railroad facilities of New England are inadequate for such shipments.

But the problems of the American railways are not the only ones which must be solved. The French bridges and tunnels have smaller capacities than ours. Therefore, when large shipments of electrical machinery go to France or South America (for the conditions are the same) the usual method of packing, skidding, etc., must be altered.

An interesting example is the case of the steam turbine generators that were sent to the Tuileries in France. They were packed one way for shipment from Schenectady to New York; a different way for the boat trip from New York to Bordeaux; and a third way for the rail trip from Bordeaux to the Tuileries. If they had been shipped by boat, in the same package that they left Schenectady, the cubical contents and hence the shipping charge would easily have been trebled.

The loading of these cars is not only limited but it must be made permanent. The creeping of the load on a car must be prevented. The bumping and rolling of a railroad train has been found to loosen the struts and braces unless the work is well done, and occasions have been known where the trains have been wrecked, bridges damaged, and tunnels jammed with a tangle of machinery, locomotives, and freight because a packer did not know his business.

One of the means of preventing shifting of the load on a railroad car is to load the car uniformly, not only longitudinally but laterally. The struts and braces are placed with great skill so as to prevent a concentration of the load at the end, the center, or on either side of the car.

Experience has shown, particularly in export shipment, that cautions reading RIGHT SIDE UP, HANDLE WITH CARE, FRAGILE, and even GLASS, are not respected. Large black arrows are painted on all four sides of the box with the word TOP placed permanently near the head of the arrow as well as the Frnech word HAUT, and the Spanish word ARRIBA. But if you were a Hindu unloading an elephant it is quite doubtful if you would exert yourself to let this package down gently, right side up on the barren wastes of India, or during a tropical storm in South America or China.

Expert packers have no difficulty in protecting machinery from rain and snow, wind and heat, or from the mist on the sea. This is as easy as for an ordinary citizen to wear a mackintosh or carry an umbrella. But the real deep study has been to overcome the accumulation of moisture on the machinery due to humidity, especially the humidity of foreign countries.

The rain and snow is excluded by tar-coated building paper strengthened by mosquito netting. This light filmy mosquito netting is quite useful in adding strength to the tar paper and serves the purpose admirably.

For packages that go to foreign countries an additional covering of what is known as carriage cloth is used underneath the covering of tar paper. This carriage cloth is wrapped around the machinery itself, and is held tight by strings and ropes so that no matter what position the machinery may be in it is well protected.

For many years the shipments of American machinery were damaged by rust, although they were perfectly protected from rain and storm. This rust evidently was produced by the moisture in the air, *i. e.*, the humidity.

Various experiments were tried to overcome this trouble. Special kinds of cloth and special coatings of tar were used, and in some cases an entire metal box of zinc or lead was constructed and apparently hermetically sealed up. But these all failed of their purpose. In one instance a motor was totally enclosed in a zinc tank and soldered tight. Two years

*From *The General Electric Review*.

later it was opened and there were three quarts of water in the bottom of the tank. Apparently, due to jarring and vibration, some little crack or pinhole had opened up and the box had begun to "breathe." The dampness would condense against the cold machinery, and then in the daytime when the temperature rose the box would breathe out dry air. Thus with the rising and the setting of the sun moisture was carried into the box, which was thought to be hermetically sealed.

The shipping men were baffled—they gave up the problem as hopeless. Someone thought of consulting Dr. Steinmetz, the chief consulting engineer of the General Electric Company. And here is shown the advantage of a complete organization where the experts in different lines can exchange information for the benefit of the several departments.

Dr. Steinmetz advised that the boxes be made open instead of closed, and that breathing holes be provided to keep the temperature inside the box practically the same as the temperature outside the box. The Shipping Department conducted many experiments and eventually a method was developed which solved the problem. The great generators for the London Underground Railroad were delivered free of rust, but it was found that the mice on shipboard had taken advantage of the breathing holes in the boxes, and had eaten off the insulation from some of the copper wires. So from that time on a wire screen or netting was tacked on the inside of each hole.

The breathing holes are not made too close to the top, bottom, or sides, for fear water might wash into them. To provide against the possibilities of these boxes being laid over on one side, thus bringing the holes on the top, a funnel-shaped shield is tacked on the inside of the box around the hole, and this shield or funnel traps the water and diverts it down the side of the box, away from the machinery.

Shipping experts in Schenectady who have had unequaled opportunity to study these questions say that shipments of electric apparatus which may now be lying at the port of Vladivostock in Russia are as free from rust and other damage due to the elements as though they had been standing in the shops of the Company.

The method just described is for large pieces of apparatus. For the smaller delicate apparatus, such as instruments, which are liable to damage from moisture in very minute quantities, a pitch-covered canvas is used inside the box, and not a complaint has been received from any quarter of the world in the three years that this method has been in use. This is applicable especially for boxes which are small enough to be handled by one man. This pitch-covered canvas is more effective than any metal casing because of its clinging qualities, and the fact that if subjected to pressure or distorted it is not in any way weakened; for the more it is compressed the tighter the wrapping becomes—exactly opposite to the case of a metal box.

From the customer's standpoint it is ideal to receive the completely constructed machine. For instance, the Panama locomotives were built at the factory, shipped on the decks of the vessels, and when lifted onto the pier at Panama they were run off by their own power.

The ideals towards which the packing experts strive, in the order of their importance, are as follows:

1. Get the shipment to the customer without breakage.
2. Get the shipment to the customer without rust or other damage by moisture.
3. Deliver it as nearly completely assembled as possible.
4. Deliver it as quickly as possible.
5. With as small an expense for transportation as possible.

So important is the work that a shipping committee has been appointed to standardize this portion of the General Electric Company's work at all of the different factories. The Committee consists of eight men from the various works, and they meet four times a year or oftener to discuss problems and settle matters of detail and policy. This committee thus acts as a clearing house of shipping information and experience.

Each type of apparatus has assigned to it a definite box, of definite size and material, put together in a certain way, wrapped, tagged, etc., according to definite specifications, written down and even illustrated.

There are 750 kinds of boxes represented, and directions covering many different methods of loading flat cars, in which are specified the braces, struts, skids, etc., which should be used. All these add not only to the safety but to the speed of shipment.

The United States Government recognizes the value of expert shippers and has created a Committee on packing, boxing, and crating, as it is now shipping untold millions of tons to all parts of the world.

The Committee has prepared standard specifications for packing different types of supplies, apparatus, etc., and personally instructs those officers who have charge of this work at Washington and at the various points of embarkation.

As an example of the benefit of the recommendations of this Committee, we will cite one instance in particular—a shipment of 10,000,000 cases for France. The Committee was asked to give its recommendations on the boxing of each of these 10,000,000 cases. Although the proposed cases had been whittled down as far as the manufacturer thought it could be done with safety, the Committee developed a new method which cheapened the manufacturing cost of each box 25 cents and also reduced its cubic displacement one-half cubic foot. This saved $2,500,000 in the cost of the boxes; but this is not the whole story. The 5,000,000 cubic feet of shipping space which was saved is worth from two to five dollars per cubic foot at standard freight rates, or again, from the standpoint of conserving ship space, 5,000,000 cubic feet displacement is equivalent to 125,000 tons, as 40 cu. ft. of this character is rated as one ton in marine estimates. Thus this one recommendation of the boxing and crating experts conserved shipping equivalent to the combined cargo space of 31 4,000-ton ships.

Manufactured Ships

(Concluded from page 131)

channel is delivered to the shipyard. It was a source of gratification to the men in charge of erection to find when the first ships were being constructed that the rivet holes in the frames and the shell matched almost perfectly.

The frames in the moulded portions of the ships were a source of worry, as it was here that the system of "manufactured work" would either stand or fall. If it were found to be possible to get a good match with the rivet holes in that part of the ship where the shape was changing in both directions, *i. e.*, horizontally and vertically, then the criticism of the unbelievers in "manufactured" ships would fall flat. The writer found at Hog Island that the matching of frames and floors in the ends of these boats was far better than was expected by him and many others; in fact, it proved to be much better than has often been observed in vessels which were being built by the old method by men who were not so careful in the work as they should have been. In general, it appears to be just as possible and practicable to have as good a fit with the "manufactured" material as it is to have plates and angles prepared in accordance with the general custom.

The shell plating of the hull structure is divided into the bottom plating, which extends from the keel to the turn of the bilge, and the side-plating, which extends from there up to the upper deck. There are three types of plating, viz., the "flush," which is not used on merchant ships because it is difficult and expensive; the "joggled," where the plates have an offset along the edges allowing it to set close to the frame bar with the lap outside of the adjoining row of plating, which is done to avoid the use of "liners" or distance pieces fitted between the frame and the plate; and the "in and out," which is most commonly used, in which all of the surface of the plate is flat. The "in and out" type of plating was adopted for these ships. The "bilge" strake is fitted as an inner and the "sheer" strake as an outer row. This arrangement provides easy working at the bilge and the sheer strake is often reinforced by "doubling" plates at the break in the bridge deck, which provides the additional strength needed to resist the maximum bending when in a heavy sea. The doubling plates in this case were fitted under the sheer strakes. The shell plating was received by the shipbuilders all punched and ready for erection, and it was found that the matching of the rivet holes was excellent. A portion of the keel at the extreme forward and aft ends was shaped but was not punched for rivet holes. The plates just forward and aft of the bilge were also delivered blank. It was a simple matter to "lift" the template for these few plates, lay off for the rivet holes and drill them with portable air drills. The "boss" plate—all of these vessels are fitted with a single screw propeller—at the stern, is rounded to fit the "boss" on the stern casting and is left blank, the holes being drilled at the shipyard.

All of the plates which were attached to the stem were left blank at the forward end. The stem casting was delivered blank and the rivet holes drilled at the shipyard. The after ends of those plates which fitted against the stern frame were also left blank and were drilled at the shipyard. Thus the shell plating was delivered practically ready for erection with the exceptions noted.

The hold stanchions were formed of a heavy I-beam reinforced with additional side plates and connected at the top and bottom by means of bracket plates and angle clips to the tank top and to the underside of the deck above. The lower hold stanchions extended to the lower or second deck and the upper stanchions were between the second deck and upper deck. The rivet holes of these stanchions matched exactly the holes in the other parts of the ship's structure.

CONCLUSION.

It is noteworthy that with the exception of a few minor changes the ships have been assembled with very few alterations in the material as received.

The yard building the smallest sized ship of the three mentioned in this paper has kept twenty-eight steel mills busy turning out the material and fifty-six shops busy in preparing it for the shipyards. This size ship requires about 427,000 rivets, and of this number about 100,000 were driven in the shops before the material reached the shipyard. This will give some idea of the vast amount of work which has been saved the shipbuilders; the other "fabricated" yards are being supplied in the same proportion.

Relatively little electric welding has been done on these ships. The connections have all been riveted joints with the exception of a little work around the "otter gear plates" on the stem and such small joints, where strength was required.

This brief outline of the method adopted for building "manufactured ships" indicates the advantages to the shipyard manager of any plan whereby his material will come to him all ready for erection. The utilization of "manufactured material" will reduce the time required in construction and should tend to help the shipbuilders quickly and cheaply to construct ships in order that they may compete successfully with foreign shipyards and foreign wages.

The Parent of Actinium

In a full historical introduction, the data obtained in 1909 relative to the rays and products of uranium X are discussed in so far as they throw light on the various possible modes of origin of actinium. The minute growth of actinium previously put on record [see Sci. Abs. 105 (1913)] as having been observed in the old uranium preparations has been confirmed by their later history and is now established beyond doubt.

Uranium X_1 can be separated from UrX_2 by sublimation in a current of air charged with vapors of carbon tetrachloride at a temperature below visible red-heat. 470 gm. of a very pure Indian pitchblende were similarly treated, in the expectation of removing eka-tantalum, isotopic with UrX_2 and giving actinium in an a-ray change of long period. The preparations so obtained were initially free from Ac, but one of them has produced it continuously with the lapse of time. A direct comparison of the amount of Ac in this preparation after the lapse of 2.5 years with that in the original pitchblende showed that it was equal to that in about 0.5 gm. On the assumption that eka-tantalum and actinium are both long-lived, that no intermediate members intervene between them, and that the preparation contained the whole of the parent Ac in the original mineral, the period of average life of Ac is calculated to be 5,000 years. Nothing can yet be said definitely as to the period of the parent.

A second preparation separated from Joachimstahl pitchblende, the treatment of which commenced in 1903 and ended in 1914 with the carbon tetrachloride sublimation, has given a similar growth of actinium. The work was undertaken to test and confirm the view that the parent of Ac occupies the eka-tantalum place in the Periodic Table, and gives actinium in an a-ray change of long period, being itself formed as the product of UrY, discovered by Antonoff, who suggested that it was the first member of the Ac series. But this mode of origin of actinium, though at present the most probable, has not yet been conclusively established to the exclusion of all the other possible modes of origin, discussed in the historical introduction.—*Sci. Absts. on a paper by F. Soddy and J. A. Cranston before the Royal Society.*

Nutritive Value of the Banana

The banana is unable to supply adequate material for the growth or maintenance of albino rats, being deficient in protein and in the water-soluble accessory substance. The addition of casein and yeast or carrot extract to the bananas renders the diet sufficient for growth and maintenance purposes. The casein in the diet cannot be satisfactorily replaced by beef protein.

Internal-Combustion Marine Engines*

Two-Cycle and Four-Cycle Types Compared

By Giovanni Chiessa, Manager of Messrs. Ansaldo San Giorgio's Works at Turin

THE relative superiority of two or four-cycle internal combustion engines for marine purposes is one of the most debated questions at the present moment from a theoretical as well as from a practical standpoint: thus it forms daily the subject of discussions, lectures and articles in technical reviews. The chief purpose of this article is to co-ordinate the arguments which have been alleged for and against both types in their best form of construction, and to endeavor to draw a conclusion after careful consideration of all points of the question.

The advantages which are usually attributed to the two-cycle engine as compared with the four-cycle type may be briefly stated as follows:

(A) The two-cycle engine develops a greater power than the four-cycle with the same number and size of the cylinders and the same number of revolutions. This advantage of the two-cycle type is due to the fact that the four-cycle type gives an impulse for each cylinder every two revolutions, while the two-cycle type gives an impulse each revolution; theoretically the two-cycle type should therefore develop, under the same conditions, a power double that of the four-cycle type. In practice, however, the said theoretical limit has never been reached, but at present it may be said that the power developed by a two-cycle engine is 175 per cent. to 190 per cent. of that of a four-cycle engine, and it may be added that while the mean effective pressure in the four-cycle type is about 5 kg. per cm.^{2} (71 lb. per sq. inch) that of the two-cycle type is practically of 4.4 kg. to 4.75 kg. per cm.^{2} (62 to 67 lb. per sq. inch).

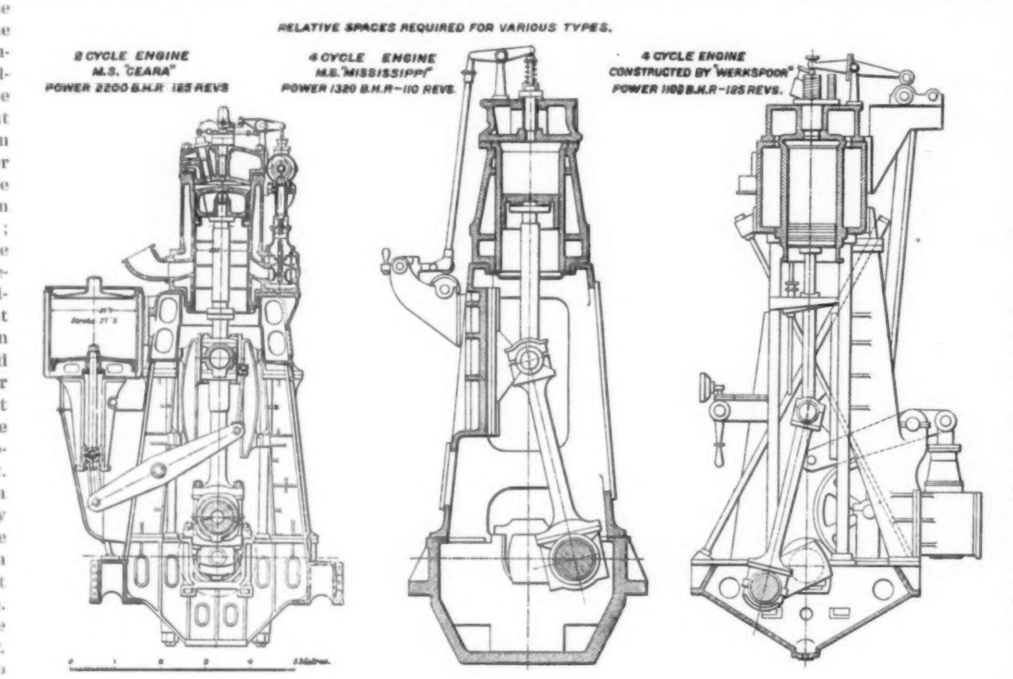

Figure 1

This essential advantage of the two-cycle type brings as a consequence a remarkable reduction of space and weight, which may be approximately calculated in the following manner: As there is no reason that a four-cycle cylinder with its framing and driving gear (assuming the same intensity of stress of the materials) should weigh less than a two-cycle cylinder of the same size, and as the weight can be practically considered to be proportional to the volume swept by the piston, therefore, for the same power and number of revolutions, the cylinder of the two-cycle engine (175 per cent. being taken as the power-ratio of the two-cycle to the four-cycle type) has a weight which is 57 per cent. of that of the four-cycle engine.

This advantage is somewhat reduced by the fact that the two-cycle engine needs scavenging pumps, and as, according to circumstances and to the different design of the pumps, their weight can be considered as being 8 per cent. to 12 per cent. of the weight of the cylinders, it results that the weight of the two-cycle type will be 62 per cent. to 65 per cent. as compared with the weight of the four-cycle. The above figures seem also practically confirmed, though there is always some difficulty in comparing numbers quoted by different constructors, for they do not always state which parts of the equipment of the plant are included or excluded from the figures published. But besides the saving of weight there is also the saving of space, and on this particular point it is preferable to refer the reader to the diagrams, Figs. 1, 2, 3 and 4, which show the two-cycle engines of the ship Ceara constructed by the firm of Fiat San Giorgio (now Ansaldo San Giorgio), as compared with four-cycle engines of the two best-known types: Burmeister and Wain, and Werkspoor.

It must be noted that the saving in space by the two-cycle type has also as a consequence a considerable saving in the cost and weight of the engine seat as well as in the dimensions of the engine-room, facilitating the supervision and control of the machines.

(B) The turning-moment in the two-cycle engine is far more regular (for the same number of cylinders) than in the four-cycle type; Fig. 5 compares the diagrams of the turning moments of a four-cycle six-cylinder engine with that of a two-cycle six and four-cylinder type, illustrating the great difference in the regularity of the two types; the results attained even in the four-cylinder two-cycle type are far more regular than those of the six-cylinder four-cycle engine.

This advantage of the two-cycle engine is not merely theoretical, but in practice results in a minor intensity of the vibrations of the stern end of the ship, besides a reduction in size and weight of the line of shafting and consequently of its fittings, such as supports, stern tube, etc. According to the rules of Lloyd's Register, the section of the shafting of a six-cylinder four-cycle engine (for the same power and the same number of revolutions) ought to be 45 per cent. greater than that of the six-cylinder two-cycle engine, and 11 per cent. greater than that of the four-cylinder two-cycle engine.

Furthermore, the reduced size of the flywheel in the two-cycle engine and the reduced space permits of placing the engine much nearer the stern, not only saving in the length of the line of shafting but also increasing the space available on board for the cargo.

(C) The two-cycle engine offers greater facility in reversing as compared to the four-cycle type, which is due to the fact that in the former the exhaust of the burnt gases takes place through ports in the cylinder wall, so that in order to reverse the running it is only necessary to alter the timing of the scavenging valves, of the fuel valve and of the starting valves. This alteration in the timing of the scavenging valves is very readily made by simply rotating the camshaft relatively to the crankshaft, while the alteration in the timing of the fuel and starting valves (these valves having but a small lift) can be readily effected by employing double cams sliding on the shaft.

In the four-cycle type on the contrary, besides the alteration in the timing of the fuel and starting valves, it is necessary separately to reverse the inlet and exhaust valves; and as the latter operation requires a different rotation of the camshaft, it is not possible to employ the simple device of the two-cycle type, but much more complicated mechanisms become necessary.

Referring, further, to the starting and reversing devices, it may be added that the necessity of being able to start the engine whatever be the position in which the crankshaft has stopped, that is to have at least one of the cylinders in the inlet phase of the starting air, does not permit of a reduction in the number of the cylinders to less than six in the four-cycle type, while the two-cycle can be constructed with but four and keep its perfect manœuvreability.

(D) With the two-cycle engine the inertia of the reciprocating parts, such as connecting rods, pistons, &c., is balanced at top dead centre by the pressure on the piston, which cannot be realised in the four-cycle for the exhaust and suction strokes. As a consequence, in the four-cycle engine the piston rods are subjected to alternative compressive and tensile stresses, so that the caps and bolts of the connecting-rod heads and of the main bearings must be necessarily constructed much more strongly than in the two-cycle type in order to avoid the possibility of their breaking and the great damage which this would cause.

(E) The two-cycle engine does not require any exhaust valve for the burnt gases, and in the engine provided with port scavenging there is no need of any valve subjected to the action of the burning gases; in the four-cycle type the exhaust valves are the source of well-known troubles and even in the case where their tightness and durability is increased by using more or less complicated cooling devices, the danger of their falling into the cylinder, with all its serious consequences, can never be fully eliminated.

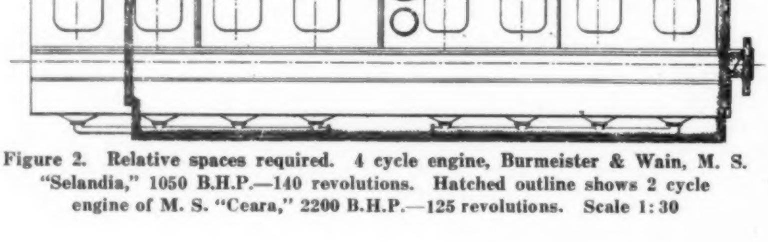

Figure 2. Relative spaces required. 4 cycle engine, Burmeister & Wain, M. S. "Selandia," 1050 B.H.P.—140 revolutions. Hatched outline shows 2 cycle engine of M. S. "Ceara," 2200 B.H.P.—125 revolutions. Scale 1:30

It should be noted that the exhaust valves in the four-cycle engine are the parts which are most sensitive to the quality of fuel and are especially liable to suffer by the asphaltum and sulphur sometimes present in heavy oils of certain origins. For a two-cycle engine without exhaust valves there may consequently be used certain kinds of fuel which are not suitable for a four-cycle engine.

Against the advantages above referred to as to the two-cycle type, the advocates of the four-cycle engine oppose some objections which partially apply to all two-cycle engines, and partially only to special types or to constructive details of them, mostly found in the older types. These objec-

*From *Engineering*.

tions may be briefly stated as follows:

(*a*) In favor of the four-cycle type it has been said that the experience of the gas engine has led back again (after a period of preference for the two-cycle type) to the four-cycle engine; also several failures are imputed to the Diesel two-cycle engine, so that it is convenient to select again the four-cycle type.

Against this objection we may note that the example of the gas engine is not directly applicable; the two-cycle gas engine, as compared with the four-cycle, shows the disadvantage of a greater consumption and of an inefficient regulation at light loads; the greater consumption being due to the fact that a certain amount of gas is always mixed with the scavenging air because the two fluids cannot remain wholly separated, and so unburnt gas escapes with the air through the exhaust ports without producing any useful work. The bad regulation is due to the difficulty of having the right mixture in case of light loads, because in the two-cycle engine it is impossible to regulate the power without diluting the explosive mixture. Neither of the said inconveniences exist in the Diesel engines, the scavenging being made with pure air and the regulation being obtained in exactly the same manner in both the two-cycle and in four-cycle types. Moreover, it may be stated that notwithstanding the said inconveniences, which cannot be neglected, the gas two-cycle engines are still constructed, and in work for many hundred thousands of horse-power, from which we may draw the conclusion that the two-cycle engines offer other real advantages.

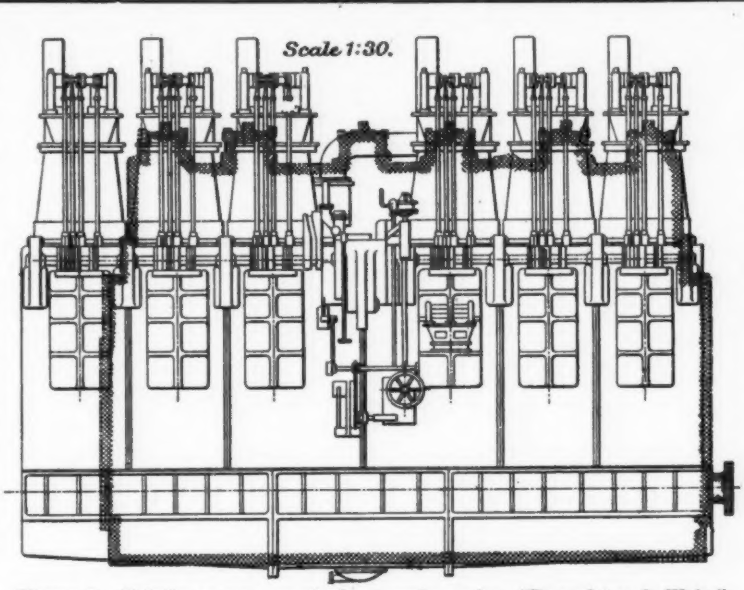

Figure 3. Relative spaces required. 4 cycle engine, "Burmeister & Wain," M. S. "Mississippi," 1320 B.H.P.—110 revolutions. Hatched outline, 2 cycle engine, M. S. "Ceara," 2200 B.H.P.—125 revolutions.

More suitable than the example of the gas engine for comparison is that of the hot bulb engines where the two-cycle type is pre-eminent, for the Bolinder, Skandia, Fairbanks-Morse, Petter, Torbinia types, a.s.o., have almost completely eliminated the competition of the four-cycle type specially for high powers.

Referring now to some failures of the two-cycle Diesel engine, it may be said they are mainly due to constructive defects; the engines of the ship Sebastian have been replaced by the four-cycle type on account of the defective construction of the details of the piston cooling device; the engines of the ships Arum and Arabis have shown defective lubricating systems; numerous inconveniences have been experienced in the engines with stepped pistons, and it would therefore be wrong to attribute these failures to the type of the engine in itself instead of to defects in the design.

Other failures ought to be attributed to the inexperience of constructors who, knowing but little of the two-cycle type, have risked building engines of great power and high speed. The two-cycle type of engine is not easy to design; the scavenging of the cylinder is a very complicated problem, and it has not been possible to study it experimentally in all details although many trials have already been made, the most important of these being that of the Krupp firm, which has made a cinematograph record by using a glass cylinder. For scavenging it is necessary that the air current in the cylinder should fully and readily displace the combustion residues without mixing with them. The study and design of a convenient system of ports passages,

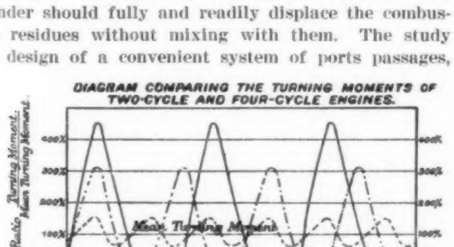

Figure 5

as well as of suitable scavenging organs, in order to obtain a perfect scavenging, and at the same time the most reduced power-consumption for driving air pumps, is a problem which can only be solved completely by many trials and long and costly experiments.

Should the cylinder and the scavenging ports not be well designed, and the scavenging be imperfect, the working of the engine will be bad; instead of having the cylinder filled with pure air for the combustion, there will be therein a mixture of the air with the burnt gas not fully exhausted, so that the combustion will take place irregularly and be delayed, the fuel being therefore inefficiently utilised and at the exhaust such temperatures may be reached as may greatly reduce the durability of the cylinders and of the engine itself.

The two-cycle engines which are constructed at present by experienced manufacturers, and especially those with port scavenging, are by no means less reliable than the four-cycle type. For obvious reasons it is not possible to speak of engines installed on warships (the brilliant trip of a small Russian submarine from Spezia to Arkangel cannot be forgotten), but the success of the Monte Penedo and of the Ceara, which latter is the most powerful ship in service at present, are undeniable proofs that the two-cycle engine, if well constructed, can give the best results.

Considering the extensive use made in the German navy of combustion engines of both the four-cycle and the two-cycle types, it is noteworthy that the important company, Hamburger Werft A.G., recently founded by the A.E.G., and by the Hamburg-American Line, for the construction of motor-ships, under the management of the well-known Ballin, will give the preference to the two-cycle engine.

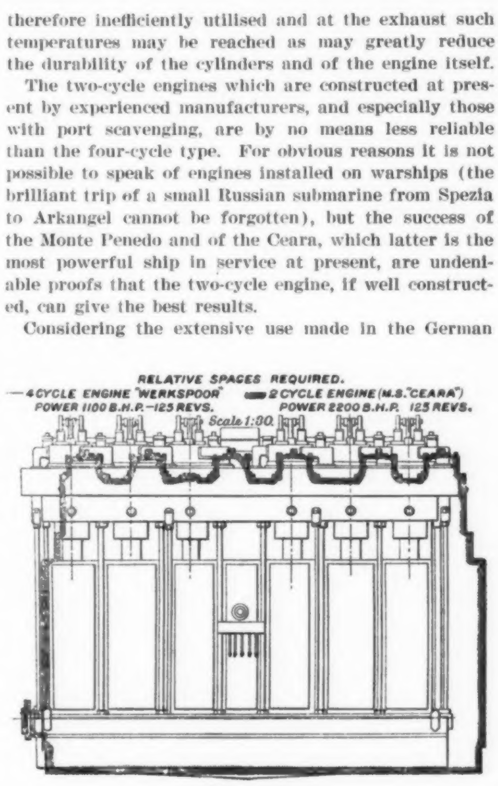

Figure 4

(*b*) The supporters of the four-cycle type allege that the two-cycle engines are far more complicated, not only on account of the scavenging pumps, the piping and the receivers relating thereto, but also on account of the greater complexity of the valve gear.

Against this assertion it may be objected that the air pumps which undoubtedly constitute an added organ, by no means interfere with the reliability of the working of the engine, as they are always working at very low pressures and temperatures like the low-pressure cylinders of steam engines; and constructively it is certainly more rational to employ a suitable air pump instead of using, for half the time, for displacing the air, enormous pistons which have been designed and fitted with rings for at least a hundred times higher pressure.

Referring now to the valve gear, the complexity pertains exclusively to that two-cycle type of engine having scavenging valves in the cylinder-heads, while in the recent type with port scavenging, besides the fuel and the starting valve (like that of the four-cycle type), there is only the scavenging valve to control. This is light and easily displaced, as it is not subjected to the hghest pressures and temperatures of the cycle, and it does not require to be perfectly tight. This valve can easily be replaced by a rotary valve. In the cylinder of the four-cycle engine, instead of one scavenging valve there are two at least to be controlled, and very often two inlet and two exhaust valves, which, being placed in the combustion chamber, require to be perfectly tight and need a precise and reliable operating gear in order to withstand the effort of the powerful closing springs.

(*c*) In favor of the four-cycle type it has been furthermore affirmed that its fuel consumption is far lower than that of the two-cycle engine. Now even if it must be admitted that this objection is correct in relation to the first two-cycle engines which were constructed, and is also applicable to some present motors of defective construction, it has, nevertheless, lost much of its importance when comparing the four-cycle engine with the best-known modern two-cycle engines.

For slow two-cycle engines the consumption may be reduced under 200 grammes (0.344 lb.) per b.h.p. per hour. The consumption of 194 grammes per brake horse-power has been obtained since 1915 with the 2,200 brake horse-power two-cycle engines of the ship Ceara on a brake test, with the most careful observation and all auxiliary pumps (such as scavenging, compressing and water, or oil pumps) directly driven, working with heavy oil of a poor quality of the density of 0.90. For the high-speed engines we may cite figures comprised between 203 grammes (0.447 lb.) and 210 grammes (0.463 lb.) per brake horse-power as resulting from the official tests of many two-cycle engines of the power of 350 brake horse-power at 480 revolutions and of 1,350 brake horse-power at 350 revolutions.

The following are the figures for consumption of fuel obtained in recent official tests on an Ansaldo San Giorgio engine of 1,300 h.p., 350 revolutions, furnished to an allied Government:

	Horse Power.	Revolutions.	Gr.
At 4/5 of power.........	1110	292	194
At full power...........	1339	352	203.1
With 10 p.c. over power..	1425	356	202.9

The consumption of lubricating oil was about 6 grammes (0.013 lb.) per horse-power per hour, although the lubrication was very abundant inasmuch as the motor was new.

The consumptions ascertained for the four-cycle engines are not much different; the data which have been published as to the slow marine four-cycle engines show 182 grammes to 188 grammes (0.401 lb. to 0.414 lb.) per brake horse-power, often excluding the consumption of the auxiliary pumps which were separately driven. With the high-speed type the competition of 1913 of the German Admiralty for electric sets developing 300 kw. at 400 revolutions, in which the most important manufacturers specialising in the construction of the Diesel engines took part (for instance, M.A.N., Krupp, Koerting) has led to figures, which were officially published in *Der Oelmotor*, 1913, and acording to which the consumption in the four-cycle

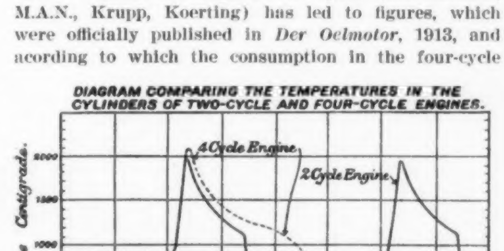

Figure 6

engines was from 197 grammes to 203 grammes (0.434 lb. to 0.447 lb.) per b.h.p. per hour.

It is true that some excessively low figures have been singly reported for the consumption of four-cycle engines, but they can be safely overlooked upon consideration of the circumstances of the test or of the uncommonly high consumption of the lubricating oil, which was obviously partially burnt as fuel, so that the above-stated results can be quoted as corresponding to the best up-to-date constructions. Though they still show a slight advantage for the four-cycle engine, this is not greater than 3 per cent. or 5 per cent., and if

we consider the other elements required for calculating the real working expenses, this difference is not of great importance. It must, indeed, be noted that the installation of two-cycle instead of four-cycle engines for a given type of ship, results in a saving in weight and space, and therefore a reduction of displacement and the possibility of increasing the run of the stern (this leading to a reduction in the power for propelling the ship at a certain speed). This advantage amply compensates for the slightly greater fuel consumption, specially in high-speed ships where the weight and the space taken by the propelling plant have the greatest influence. Furthermore, it may be added that, even if the question of the weight and space should be regarded as a secondary one, still the two-cycle engine shows the advantage that the particulars being the same, it can develop the same power as the four-cycle one at a much lower speed of revolution, with the consequence of a reduction in the consumption and of a much better efficiency of the propeller. It is also very likely that as the consumption in the two-cycle engines has decreased, as a consequence of rational and systematic experiments, in a few years, from 250 grammes or 200 grammes per brake horse-power, to the present values it will still improve until it reaches and even surpasses the low consumption of the four-cycle type. Theoretically there is no reason why this should not happen, for the thermal efficiency is the same in both types, and the power required by the two-cycle engine cannot be greater than the power expended in driving the main pistons of the four-cycle engine to work half the time as pumps themselves.

Finally, besides the fuel consumption, that of the lubricating oil, which is much more expensive, ought to be considered. It is obvious that the two-cycle engine should require a less quantity of oil than the four-cycle, the load on the piston of the four-cycle engine being 50 per cent. greater (with the same number of cylinders and the same ratio between diameter and stroke) than that of the two-cycle, the pressure exerted on the bearings, and on the guides being proportionally increased, so that the surfaces to be lubricated are accordingly larger. In practice, however, as the two-cycle engine may be constructed with fewer cylinders the saving in the lubricating oil is still more evident. At present the figure of 3 grammes to 4 grammes (0.00614 lb. to 0.008818 lb.) per brake horsepower as the total amount of oil consumption is usually reached in high-speed engines (480 revolutions).

(*d*) As another advantage of the four-cycle type it is affirmed that the cylinder wall never reaches such high temperatures as in the two-cycle type, so that the latter are subjected to higher internal strains and thus to the danger of cracks. Now, while it is true that the ratio between the quantity of the fuel burnt in the four-cycle type and the surface of the combustion chamber is hardly superior to one-half of the same ratio in the two-cycle engine, other important circumstances have been overlooked which have certainly a great influence on the mean temperatures.

The action of the hot gases on the cylinder walls lasts certainly a shorter time in the two-cycle than in the four-cycle type. While in the latter the cylinder walls undergo the action of the hot gases during the whole expansion and exhaust strokes, that is, practically for more than half the time, in the two-cycle engine the action of the hot gases lasts only for little more than two-thirds of the working stroke.

In two-cycle engines in which the exhaust occurs through ports, the latter open much more rapidly than the exhaust valves of the four-cycle engines, and consequently there is a much more rapid diminution in the temperature due to expansion.

While the exhaust temperature in four-cycle engines is seldom below 350 deg. C. and in the high-speed engines it easily reached 450 deg. or 500 deg. C., in two-cycle engines, if well constructed, this temperature usually remains under 250 deg. C., and sometimes it only reaches 200 deg. or 210 deg. C.

Taking account of this fact a diagram has been drawn of the relative temperatures of the high-speed four and two-cycle engines (Fig. 6), which has no absolute value but merely a relative one. It is based for both types on the same hypothesis, that is, volumetric efficiency 80 per cent., referring to air at the atmospheric pressure and at 15 deg. C., adiabatic expansion, mean effective pressure 5 kg. per cm.^{2} for the four-cycle and 4.375 kg. per cm.^{2} for the two-cycle engine (corresponding to the ratio of 1.75 between the volumes of piston displacement); fuel consumption 198 grammes per brake horse-power for the four-cycle and 208 grammes for the two-cycle type; exhaust temperature of 450 deg. for the four-cycle engine (being the average temperature as ascertained in the high-speed engines presented at the competition of the German Admiralty above referred to). For the exhaust stroke in the four-cycle engine the curve of the temperatures is such as practically ascertained according to Dr. E. B. Wolff's experiments (see *Oelmotor*, 1915), where for the suction stroke a gradual mixing of the residual exhaust gases in the compression space with the atmospheric air has been assumed.

Not one of the hypotheses above referred to is in favor of the two-cycle engine; the hypothesis of the same initial compression temperature in both types is unfavorable for the two-cycle type, as all experiments which have been made with gas engines confirm that in the two-cycle engines a much higher compression ratio can be employed than in the four-cycle, without the danger of premature ignition, and that the mixture at the beginning of the compression is therefore cooler in the two-cycle type. By measuring the diagrams by a planimeter, however, the conclusion was reached that the mean temperature of the two cycles is practically the same.

The above result is confirmed by measuring the quantities of heat absorbed by the circulating water in the two-cycle and in the four-cycle engines. While in the slow four-cycle engines without piston-cooling the quantity of heat which the cooling water carries away from the cylinders is usually from 580 calories to 650 calories per brake horse-power, and in the high-speed engines with piston cooling from 800 calories to 850 calories (these figures have been ascertained in the four-cycle engines of the German Admiralty's competition referred to), in the two-cycle engines of a suitable construction the corresponding number of calories is from 400 to 450 in the slow and 500 to 550 in the high-speed engines. While it is true that the cylinder in the two-cycle type, having the same power, exposes to the burning gases a surface which is about 30 per cent. smaller than in the four-cycle, it must, however, be remarked that the size of the cylinder of the four-cycle type being larger than that of the two-cycle, the thickness of the walls is consequently greater, and that a great part of the head surface in the four-cycle engine, owing to the presence of the valves, does not transmit any heat.

Taking account of all these elements it is fair to say that the two-cycle engine, from the standpoint of temperature, is in better condition than the four-cycle. The two-cycle engine, in which the inner walls of the cylinder, after the very short action of the flame, are immediately cooled by the scavenging air current (which is supplied in such quantity as to allow, besides the filling up of the cylinder, the escape of the warmest portion which entered at first) is thermally superior to the four-cycle engine in which all heat must be abstracted through the walls of the cylinders with the consequent fall of temperature in the walls and resultant internal stresses.

(*e*) The opponents of the two-cycle engine allege that in engines of this type some portion of the combustion gases remains in the cylinders, especially in the upper part of them, so that the cylinder head becomes excessively hot. Against this argument it must first be remarked that in the four-cycle engine at least 8 per cent. of the burnt gases remain and fill the compression chamber when the piston has completed its exhaust stroke, and it is obvious that this remaining portion cannot but contaminate the air which is drawn in during the subsequent stroke. As regards the two-cycle engine the assertion that some residue of the burnt gases still remains in the cylinder after the scavenging operation is merely a gratuitous hypothesis, which is contradicted by the facts above referred to, according to which the quantity of heat absorbed by the walls is less in the two-cycle engine, and that in the two-cycle type the compression ratio can assume a greater value than in the four-cycle engines.

During recent and accurate tests in the test-room of the Ansaldo San Giorgio works on a high speed two-cycle engine, it has been determined that the quantity of carbon dioxide contained in gas enclosed in the cylinder during the return stroke does not exceed 0.3 per cent., and that the contents of oxygen is hardly less than the content in the pure atmospheric air, *i. e.*, 20.5 per cent. instead of 20.9 per cent.

(*f*) Against the two-cycle engine it has been said that the four-cycle type can run with greater regularity than the two-cycle when working at low speed of revolutions, owing to the fact that in the two-cycle engine the compression at low speed falls rapidly with the diminishing of the scavenging air pressure. It must, however, be noted that this observation is correct merely when it refers to two-cycle engines of bad design, in which, owing to inefficient construction, the scavenging air pressure rises at the normal speed, to excessively high value, while in two-cycle engines, which have been carefully designed, even at full speed the pressure of the scavenging air remains within very small limits. By the speed reduction the pressure is also somewhat reduced, but not so as to cause failure of the ignition especially when the engine is hot. Practically, in both the two-cycle and in the four-cycle types the lowest limit of speed is dependent upon the construction of the pulveriser, and this for the two-cycle engines is more than efficient for perfect manœuvring. Moreover, it must be remarked that the turning moment of two-cycle engines being more regular, and it being possible to run with half the number of cylinders and to obtain sufficiently good regularity, the two-cycle engine shows in this particular point an advantage compared with the four-cycle type.

During official tests the above-mentioned two-cycle engine of 1,300 brake horse-power ran for a long time at 45 h.p. (*i. e.*, nearly 1/30 power) and with the corresponding speed of 115 r.p.m.

In conclusion, it may be said that the two-cycle engine shows, as compared with the four-cycle, real advantages as regards the weight, the space required, the regularity of the turning moment, facility of reversing, and absence of organs subject to the action of the flame. These are important, undeniable and positive advantages against which the advocates of the four-cycle type can only oppose statements which are partly unfounded and partly not appliable to the system itself, but to some constructive details in defective engines built by inexperienced constructors. Judging by the tests and practical results of the two-cycle engines of good construction the writer holds that this type should become standard for the Diesel marine engines, as it is already for the hot-bulb engines.

The Rôle of Forces Dominating Attraction in the Architecture of the Earth and of the Universe

ALTHOUGH gravitation appears actually to be the preponderating force in the Universe, yet it is not more universal than all the forces revealed by Physics. If gravitation, however, had been the only force concerned with the architecture of the universe, all the masses of a system would be blended by it into a single one. It is necessary, therefore, that dispersive forces dominating attraction may operate at the origin in order to prevent such amorphous agglomeration; these are molecular attraction, pressure of gases and vapors, radiation-pressure, electrical and electromagnetic forces, etc. Impacts, whether of bulk or molecular, between masses, are capable of generating heat, electricity, and rotations, *i. e.*, the majority of dispersive forces real or virtual. The growth of crystalline structure similar to that of a tree and the erection of volcanic cones or lunar craters, are due to the action of forces operating against gravity. The architecture of the earth must be traced to the primitive austral deluge. [See Abs. 823 (1914)]. This notion of architecture may be extended to the structure of masses in motion in which opposing forces produce an average stable equilibrium, *e. g.*, the solar system. Since, according to Poincaré, its stability cannot be demonstrated by celestial mechanics owing to the use of semi-convergent series, there results in practice the existence of the exponential law for the distances of planets and satellites. If the effect of the tides according to Darwin, of the medium resistance according to See, or of accumulated perturbations in the same sense had prevailed in our system, their very different effects on large and small planets and upon near and remote stars, would have destroyed every appearance of the law of distances and of planetary rotation. In consequence, the author now puts forward a general proposition, namely: the architecture of the mobile masses in the universe or immobile upon the earth is not produced by attraction, but by the forces which dominate it; the attraction only ensures stability. He then describes a mechanical model which realises the architectural characteristics of the solar system with a rule of relative stability. The results obtained are compared with planetary data, and support is thereby afforded to the author's contention that it is erroneous to regard attraction as having produced the primitive dispersive impulse.—*Sci. Absts. on a paper by E. Belot, in Comptes Rendus.*

The Work of Railroads in War

UNTIL within recent times military men have generally considered railroads solely as a means for transporting men and ordnance, which included guns of all kinds with their ammunition, to the front. How far astray they were is strikingly indicated by reports of the work done by the railways operated by the American forces in France for November, 1918, which may be regarded as typical. During this month something less than 7% of the tonnage handled consisted of ordnance. This indicates clearly that the part played by the railroad is primarily the maintenance of the men, for without men well taken care of there can be no war.

Modern Welding by Electricity*

Principles, Advantages and Recent Developments

The use of electricity as a means of welding or cutting metals, repairing cracks or breaks, recovering defective castings and for similar purposes, all generally included under electric welding, has only recently been realized to any extent by manufacturers and engineers. Although comparatively simple in theory, the development of the use of electricity in this form has been slower than any other service to which this power has been applied. This slow growth can be attributed to several causes, the principal ones being the scarcity of skilled operators and suitable apparatus for performing the operation, and the lack of accurate information on the different methods and their application.

During the last two years the scarcity and high cost of labor and materials have forced many firms to accept this method as a measure of great conservation or higher efficiency or both. Once in use its value is quickly recognized and the impetus thus lent undoubtedly assures electric welding a prominent place in the electrical field of the future. This development has already resulted in many improvements in the design of the aparatus used in this work by the different manufacturers and in the elimination of many other difficulties which were encountered in its application. The extent of its field, however, is by no means realized as yet and this is largely due to ignorance of its application and use.

The subject of electric welding may be roughly divided into two sections. These are alike inasmuch as they both use the heat generated by an electric current to bring the metal to the proper temperature for the work. The methods which they employ to produce this heat and the processes which are followed in applying it are radically different, however. Furthermore, each has its field and limitations and these, although overlapping in some instances, are so clearly defined that the two methods do not conflict in general usage. One of these methods is known as the electric arc-welding process, the other as spot or butt welding.

The first method to be treated is the electric arc-welding process. In this process the intense heat produced by an electric arc is used to bring the metal to a melting or fusing point. The flame thus created, in addition to being the hottest flame yet produced, is concentrated which permits of its application to any desired point. In modern practice this process is again subdivided into the carbon electrode or Benardos process and the metallic electrode or Slavianoff process which were first introduced about 30 years ago.

Of the two common arc methods, the metallic electrode or Slavianoff process is more generally used, although both cover a common field and the use of either is largely determined by the individual requirements. As a matter of fact modern apparatus is usually designed for use in either process. In the metallic electrode process an arc is produced between the material to be worked, which is connected to one side of an electric circuit and a rod, usually of the same metal, connected to the other side. The heat of the arc thus produced melts the rod and heats the material sufficiently to unite with the particles of metal deposited from the rod.

In the carbon electrode process the arc is drawn between the material and a carbon or graphite electrode, the metal to be deposited or filler being supplied from an outside source, fed into the arc and thus melted. Where desired, this form of arc can be used to cut the metal by burning it away.

As was stated, both of these methods cover the same general field and the selection depends upon certain features of the individual case to which they are to be applied. The metallic electrode process is generally preferable for use where the current required ranges between 25 amp. and 150 amp., although as high as 225 amp. has been used by this process. Satisfactory results cannot be easily obtained with the carbon electrode if the current used is below 300 amp., as the greater heat which it generates tends to burn the metal. In addition, the use of this electrode tends to carbonize the metal which may seriously affect its strength. However, where the material to be welded is heavy or the weld of considerable size and the strength of the resultant weld is not especially important, this electrode may be used to advantage as it is much faster than the other.

In the majority of present applications of both of these processes direct current is used at a pressure of between 20 and 50 volts across the arc. Alternating current has also been used with considerable success, but due to the low power-factor of the welding load it is not used as generally as direct current. The advocates of this class of service in arc welding however, claim many vital advantages for it and as the use of welders is advanced no doubt it will more closely compete with direct current in the extent of its field. The application with either form of service is the same, except that more skill is required in using the latter.

The low voltage required can be obtained by the insertion of resistances across any available line, but, as this method entails a considerable loss of power, special generating equipment designed to deliver the current at a much lower voltage than ordinary has been developed. This equipment for direct-current service usually consists of a generator equipped with the proper driving device, either an alternating-current or direct-current motor or a pulley for connecting to an existing mechanical power supply, the generator being designed to deliver a heavy current at about 60 volts and the whole motor-generator set being provided with the necessary resistance and control apparatus. A number of manufacturers have recently made several radical changes in this apparatus with the intention of securing a much more uniform supply and thus stabilizing the arc. For use on alternating-current circuits this change in voltage is easily accomplished by means of transformers.

PREPARATIONS FOR WELDING.

The application of electric arc welding may be divided into three distinct operations; preparing the material to be welded, striking or starting the arc, and manipulation of the electrode, filling material and the work being welded.

The proper preparation for the work is of the utmost importance. Scale, grease, dirt, etc., should be entirely removed if the resultant weld is to be free from impurities. To accomplish this the work must be first gone over thoroughly with a rough file, rasp or wire brush and where necessary a light chipping may be made over the surface to be dealt with. It is often desirable to use a sand blast to accomplish this cleaning and in many instances the impurities have been burned off with a carbon electrode arc.

The next step is the proper shaping of the surface of the material for the weld. This preparation varies widely for individual requirements but should be given adequate consideration in every circumstance. In many cases preheating of the metal may be necessary and in these cases a temporary furnace will have to be provided.

After the material is properly prepared it can be connected to one side of the welding circuit. In both methods, but more especially in the carbon electrode process, the material to be welded is connected to the positive side of the line and the electrode to the negative side. It is known that a much larger percentage of the heat of an arc is developed at the positive than at the negative pole and consequently this method of connecting is employed in order that this greater amount of heat may be applied where needed, namely, on the material being welded. In addition, experience has demonstrated that if the flow of current is from the weld to the electrode particles of unconsumed carbon from the electrode will not be injected into the weld. If these connections are reversed, a very unstable arc, a spongy deposit on the weld and a very hard and scaly weld are apt to be the result.

The selection of electrodes and material is the next step in completing the weld. There is a distinct type of holder designed for use with each type of electrode. The carbon electrode holder, on account of the intense heat generated by this process, is much heavier than the metallic electrode holder. The cables connecting to the holders and the work should be of sufficient size to carry the desired current without any appreciable loss and sufficiently flexible to permit the operator to move them about freely.

In choosing the size and types of electrodes for use on various jobs the character of the work will ordinarily be the deciding factor. The following table represents the size of iron or steel metallic electrodes for use with various current densities and the approximate thickness of the metal to be welded:

Diameter of electrode.	Maximum current.	Thickness of plate.
1/16 to 3/32 in.	75 amp	1/8 in.
1/8 in.	125 amp.	1/4 in.
5/32 in.	155 amp.	5/8 in.
3/16 in.	175 amp.	above 5/8 in.

The wire for these electrodes must be free from impurities and especially the amount of carbon, manganese, phosphorus, sulphur and silicon which it contains must be kept as small as possible.

The filler to be used with carbon electrodes may be classified in the same way as metallic electrodes. The proper size of the carbon to be used in this work may be determined from the following table:

Diameter of electrode.	Maximum current.
1/4 in.	100 amp.
1/2 in.	300 amp.
3/4 in.	500 amp.
1 in.	1,000 amp.

The use of a flux in welding is advocated by many authorities. The theory of the functioning of the flux is that if carbon is introduced into the weld from the carbon electrode, it will unite with the oxygen of the flux and disappear in the form of carbon dioxide, leaving the pure iron in the weld.

The actual welding process is started by the operator touching the electrode to the work and instantly withdrawing it a sufficient distance to maintain the arc. This is commonly called striking the arc. The distance which the electrode is withdrawn differs in the different processes. In the metallic electrode process the arc cannot be maintained if more than about 3/16 in. long and should be preferably kept as short as possible as the shorter the arc is kept the less possibility there is for the various detrimental gases to creep into the weld. This makes this method of welding much more difficult to perform than the carbon electrode process in which the length of the arc should be at least 2 in.

After striking the arc the metallic electrode is woven slowly over the place to be welded in order to bring the metal of the material and electrode to the proper condition at the same time. With the carbon electrode the arc should be played over not only the actual spot to be welded but the surrounding metal as well in order to heat the whole surface adjacent to the weld suficiently. When the metal becomes molten, the flux, if any is used, should be applied, and the filler material should be gradually fed in.

In this manipulation of the arc special attention must be given to the effects of the expansion and contraction of the metal. Owing to the fact that in the case of electric arc welding the heat is quickly applied and confined to a very small area these effects are very apt to prove dangerous. Several methods have been introduced for combating this condition, nearly all of which follow the general method of keeping these stresses at a minimum. For example, in welding a square patch, the top portion is welded first, then the side connecting the top and bottom and at which the previous welds were started and then the remaining side. In this way, all parts are allowed to cool before the next weld is started and the strains are reduced.

As soon as the metal of a weld begins to cool, it should be hammered, in order to prevent sponginess and to give the metal a finer grain and to equalize the strains.

On account of the serious effect of the ultra-violet rays which are created in an arc drawn between iron and iron or carbon and iron it is absolutely essential that suitable protection for the operator and others in the vicinity be provided. The rays produce an effect similar to sunburn on any part of the body and are dangerous if viewed with the naked eye, not only because of this actinic property but also because of their blinding brilliancy. For this reason every part of the operator's body should be covered and heavy gloves should be provided. Protecting booths should also be erected to cut off these rays from other workers in the vicinity. A light metallic headgear or hood designed to completely cover the head, face and neck of the operator with a suitable glass opening which will permit the operator to see the work but is so equipped as to absorb these dangerous rays should also be provided. This is usually accomplished by using a series of suitably colored glasses. A combination of glasses which has proven very satisfactory is, two red glasses and one green glass. A clear glass is usually put on the outside to protect these glasses from being pitted by the flying particles.

Electric arc welding, more than in any other process in which electric power is used, depends upon the skill and carefulness of the operator to produce successful results. For this reason extreme care should be taken in the selection of welders. Only men with

*From *Electrical Review.*

previous experience in similar work, such as boiler makers, blacksmiths, etc., who have proven to be neat, careful, and reliable, should be chosen for this work. These men should then be given an extensive training in this work before being allowed to actually do any welding.

The value of such training was recently given considerable prominence by the establishment of a school for welding operators by the United States Shipping Board which has been very successful in the educating of men for this work. Mere knowledge of the operation will not suffice, however, unless the operator is careful, reliable and takes a certain amount of pride in his work. For this reason, every effort should be made to instill into the men the vital character of these features. Once selected, welders should, if they prove successful, be kept permanently employed. One plan which has given considerable success is to let the welder act as a superintendent in the cleaning and preparatory process, performing only the actual welding himself. Another, is to keep an accurate record of the welds made and the welders.

As was stated, the adoption of this method of welding by the Emergency Fleet Corporation brought it into considerable prominence and gave a decided impetus to its development. The information distributed by the Welding Committee appointed by this corporation, under the able leadership of Prof. Comfort A. Adams, president of the American Institute of Electrical Engineers, has been invaluable in the elimination of many of the difficulties which formerly retarded the growth of this method of welding and in developing many new phases of its application. The perfecting and adoption of the standard form of nomenclature to be used in designing and standardizing arc welding is but one of this committee's many notable achievements.

Although the use of arc welders was given prominence by its use in shipbuilding the largest field of its former and probable future activities is in the shops of the railroads, both steam and electric. In parts of this field it has been used quite extensively for years in repairing broken parts of engines, worn track frogs, crossings, bearings, axles, wheels, etc. It is now being used in the construction and maintenance of locomotives, cars, etc. A number of railroads are now making preparations to adopt this system of welding more generally.

In addition to railroad and shipbuilding plants, practically every industry making use of iron and steel can utilize the arc welding process to advantage. The filling and repairing of defective castings by this method has enabled many manufacturers to effect considerable savings in this way for many years. To attempt to enumerate all the possible operations in which this method could be used to advantage is practically impossible, however, every firm using metals which can be welded to any extent, as well as repair shops, etc., will do well to invetigate this process and the advantages which it offers in their work.

SPOT OR BUTT WELDING.

The second method of welding by electricity is the so-called spot or butt welding. This method has been used for a number of years in the welding of small iron and steel parts and recently plates as large as 1 in. in thickness have been welded by this method. Contrary to the arc-welding process, spot welding can be easily done by an inexperienced operator and furthermore the designs of the different machines have been perfected for several years. The features which have retarded its growth therefore also differ from those affecting arc welding and can be attributed chiefly to two sources. The first is the lack of sufficient and suitable publicity given to this method and its apparatus. The second is the fact that as most of the installations use alternating current the extremely low power-factor and intermittent use of this welder make it a rather undesirable load. The advantages which can be obtained by its use, however, more than offset these undesirable load features and this method is also receiving considerable attention which promises a brilliant future for it.

In this method a large volume of current is passed at a low pressure through the contacting surfaces of the metals to be welded. The electrical resistance of these metals at the contact surface is so great that they become heated to a welding temperature. In spot welding this current is applied through two suitable electrodes, usually copper, which hold the metal firmly in place. When the metal is sufficiently heated, pressure is exerted on the parts forcing them to unite in welds.

This current is supplied to the electrodes usually from a transformer mounted on the welding machine which reduces the voltage to about 2 to 10 volts. The current required will vary, depending on the amount of resistance which the material to be welded offers, being very high if copper or similar conductor is to be welded and comparatively low for iron or steel.

The operation of a spot welder is very rapid, taking but a few seconds to produce a weld, and there is no preparatory work necessary except to clean the surfaces.

Butt welding is similar to spot welding and is generally classed with it as spot welding. The principal difference in the processes is that in butt welding, two pieces of metal are placed in jaws with the edges extending a slight distance beyond the jaws and in contact with each other. The same general process then follows. As a result, these edges are welded together over the entire contact surface, whereas in spot welding the welding is only done over a certain area and the metals held together similar to riveting.

The advantages to be derived from the use of either of these methods are too numerous to mention. Nearly all metals are adapted for use in this process although many will have to be treated after the operation either to restore them to their original strength or to repair the finish. Welds on iron made by these processes and subsequently tested, proved much stronger than riveting and compared very favorably with the strength of the metal itself. It is also much faster than riveting and much more lasting. Further, they are not affected by heat, which permits of its use in stoves, etc.

The use of spot welders is limited to metals of small size which can be brought to the machine for welding. Manufacturers of small metalware, etc., have found them a great aid in welding parts for many years. In addition, rivets of any size, after being set into rivet holes, may be heated and headed in one operation by the use of a spot welder, the results being much finer and more uniform than when the riveting is done mechanically.

The Fluorescence of Cellulose and Its Derivatives

It had previously been recorded by Hartley (Chem. Soc. Trans., 1893, 245) that cellulose in the form of white blotting paper is fluorescent and capable of rendering visible the whole of the ultraviolet spectrum as far as wave-length 2,000. This phenomenon has been studied by the author, and the effects have been recorded photographically to show the relative intensity of the degradation of ultraviolet light at various wave lengths to visible rays capable of passing through glass and affecting the photographic plate. Graphs have been constructed in which the intensities are plotted as ordinates and the wave-lengths as abscissæ. The general results show that the power and distribution of the fluorescent properties are definite functions of the chemical constitution, and their variations conform to what is known of the influence of substituent groups on the properties of the original substance. Normal cellulose, from whatever source it is derived, gives a fairly uniform spectrum, but the intensity varies with the specimen under observation. The cellulose from rhubarb stalk and cuticle falls in the same group. Modified celluloses, such as viscose fabric and parchmentised paper, show a considerable divergence from the normal; well beaten "bank" paper falls in the same class, which is characterized by a strong effect at a wave-length of 2,750. Ground wood paper (lignocellulose) is devoid of fluorescent properties, and the cellulose nitrates are nearly, if not quite, inactive. On the other hand, the acetylcelluloses exhibit a fluorescence which is generally much stronger than that of the normal cellulose, and which is much stronger towards the visible region than towards the extreme ultraviolet. For media of the same chemical constitution the resulting degraded spectrum is much the same for the transparent film through which the ultraviolet light is transmitted as for the opaque network in which it is reflected at the surface of the fibres.—*Note in J. Soc. Chem. Ind. on an article in Jour. Soc. Dyers & Col.*

To Make Liquid Indigo

To make liquid indigo the indigo plant, after being cut and gathered, is first placed in casks, specially made with plugged holes in the side, which are filled with water. After soaking a few days lime is added, and in about one week's time the stem and branches of the plant are removed. Each day the contents of the cask, after being well stirred and beaten, are allowed to settle, and on the following morning, before this process is repeated, some of the plugs are removed, allowing the water above the sediment which had formed overnight to escape. Gradually the water is thus eliminated and liquid indigo is found in the bottom of the casks. These casks vary in size, some of them being as large as 12 feet deep by 10 feet in diameter, and are made of thick pine boards held together by bamboo hoops.—*Engineering.*

A New Method of Repairing Ships

A NOVEL ship repair job has been recently carried out in Buenos Aires. The ship was a wooden vessel called the Paloma Argentina, of some 200 tons displacement. The wooden ribs of the vessel were quite rotted away at the bottom, and the repair consisted in casting in armored concrete ribs between the existing wooden ribs, the ribs being bonded to the skin by coach screws driven partly into the latter. Here and there extra deep concrete ribs with special reinforcement were taken over the inner or false keel. The repair is reported to be quite successful, and as the concrete takes the place of ballast, has added nothing to the weight of the vessel.

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

Published by Scientific American Publishing Co.

New York, Saturday, March 1, 1919

Munn & Co., 233 Broadway, New York

Charles Allen Munn, President; Orson D. Munn, Treasurer
Allan C. Hoffman, Secretary, all at 233 Broadway

The Scientific American Publications

Scientific American Supplement (established 1876) per year $5.00
Scientific American (established 1845) 5.00
The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application.
Remit by postal or express money order, bank draft or check.

Scientific American Publishing Co.

233 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

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